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NEW AND LITTLE KNOWN ANTS OF THE GENERA MACROMISCHA, CROESOMYRMEX AND ANTILLAEMYRMEX

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No. 8—New and Little Known Ants of the Genera Macromischa, Croesomyrmex and Antillaemyrmex[1]

By William Morton Wheeler

[1] Contributions from the Entomological Laboratory of Harvard University, No. 340.

Until recently our knowledge of the neotropical genus Macromischa, as defined by Roger in 1863, was rather meager, owing to the fact that all the species are rare or at any rate very local and, with the exception of one species (*M. sallei*), form small colonies, often in situations overlooked by the casual collector. In 1920, Mann, who discovered a number of new and remarkable species and revised the genus, showed that it is much more extensive than previous myrmecologists had supposed. Several collections generously contributed within the past year by Dr. Elisabeth Skwarra, Dr. W. S. Creighton, Dr. J. G. Myers, and especially by Dr. C. G. Aguayo and his assistant Dr. P. Bermudez, of the Museo Poey, Havana, contain some fourteen new forms, which are described in the following pages. I have added a species which I recently found in Florida. With these accessions, the genus, as defined by Roger and emended by Mann, now comprises 54 forms (43 species, 3 subspecies, and 8 varieties). More intensive collecting in the American tropics will, no doubt, reveal the existence of a considerable number of additional species.

In his article of 1863, Roger described seven large and beautiful species — *purpurata*, *porphyritis*, *squamifera*, *iris*, *lugens*, *versicolor*, and *punicans* — from specimens collected by the Nestor of Cuban naturalists, Gundlach. Of these I designated *purpurata* as the genotype of Macromischa in 1911, and, in 1913, added two more species, *gundlachi* and *pocyi*, which are represented by single specimens in the Gundlach collection in Havana, and had not been sent to Roger. Of these nine species, known only from descriptions for so many years, seven have been recently recovered in the field, namely, *purpurata* and *squamifera* by Mann, *pocyi* by Brunner and Ballou, *versicolor* by Creighton, *porphyritis* by Bermudez, and *iris* and *lugens* by Aguayo. *Gundlachi* and *punicans*, therefore, still remain to be recovered. Long after Roger had established his genus, Forel found that *Myrmica sallei*, described by Guérin-Méneville in 1852 from Santo Domingo, is a true Macromischa. Other species of the genus have been added from time to time by Emery, Forel, Mann, Menozzi, and myself.

Emery, in a short paper published in 1896, recognized only eight valid species of Macromischa, six described by Roger and two by himself (*pastinifera* and *pulchella*). *M. cressoni*, described by Ernest André from Mexico in 1887, and Roger's *punicans* he withdrew from the genus, regarding them both in 1896 as belonging to the genus Aphaenogaster, and in 1915 as being merely minor workers of Pheidole. To this interpretation he adhered in the "Genera Insectorum" (1921). He was undoubtedly correct in regard to André's species, of which he had examined a cotype, but as I shall show on page 29, he was certainly wrong in regard to *punicans*, which he knew only from Roger's description.

Roger's seven species were so diverse that he emphasized the heterogeneous character of the genus. In 1930, Mann in his revision divided the genus into three subgenera, namely: Macromischa *sens. str.*, comprising the species with epinotal spines and long petiolar peduncle; Croesomyrmex with unarmed epinotum; and Antillaemyrmex, comprising small, terricolous species, with epinotal spines, but with short petiolar peduncle. At the present time it seems preferable to regard Croesomyrmex and Antillaemyrmex as distinct genera. The status of the latter, however, is somewhat doubtful, because at least one species of Macromischa *sens. str.*, namely *pastinifera* Emery, is terricolous, according to Creighton, and one species of Antillaemyrmex (*floridanus*) lives in twigs, and because the species *melanocephala*, described below, is very much like an Antillaemyrmex, except in the shape of the petiole. Perhaps the males may be useful in defining these genera more accurately, but as yet no male Antillaemyrmex is known.

The geographical distribution of the three genera is peculiar and concentrically overlapping. Macromischa *sens. str.* has the widest range, including the Bahamas, Greater Antilles, and the North American continent from Panama to central Texas. No species, however, are known to occur in Jamaica or the Windward Islands. Antillaemyrmex is less widely distributed, being confined to the West Indies (Bahamas, Cuba, Haiti and Santo Domingo, the Virgin Islands) and to Florida. Croesomyrmex is known only from Cuba.

The habits of the species of the three genera are remarkably diverse. We now possess notes on the nidification of some twenty-nine species. In the following list, the first observer of the nesting habits is cited in parenthesis:

(1) Making ovoidal carton nests on trees: *Macromischa sallei* (Guérin), subsp. *haytiana* (Mann).

(2) Nesting between the leaves or among the roots of epiphytic Tillandsias, or among the roots of epiphytic orchids: *M. petiolata* (Wheeler); *isabellae* (Wheeler); *purpurata* (Mann); *skwarrae* sp. nov. (Skwarra); *flavitarsis* (Skwarra); *annectens* (Skwarra).
(3) Nesting in hollow twigs of trees or shrubs: *M. flavitarsis* (Wheeler, Skwarra); *fuscata* (Wheeler); *isabellae* (Wheeler); *purpurata* (Mann); *azteca* sp. nov. (Skwarra); *Antillaemyrmex floridanus* sp. nov. (Wheeler).
(4) Nesting in dead twigs on the ground: *M. squamifera* (Mann).
(5) Nesting in the hollow stems of sedges: *M. splendens* (Wheeler); *allardycei* (Mann).
(6) Nesting in bark, dead or decaying wood: *M. subditiva* (Wheeler); *flavitarsis* (Wheeler); *affinis* (Mann).
(7) Living in crevices of limestone rocks or cliffs, often with more or less tubular carton entrance: *M. creightoni* (Creighton); *myersi* sp. nov. (Creighton); *manni* sp. nov. (Creighton); *porphyritis* (Aguayo); *Croesomyrmex wheeleri* (Mann); *versicolor* (Creighton); *lugens* (Aguayo); *aguayoi* sp. nov. (Aguayo); *poeyi* (Aguayo), and probably also *bermudezi* sp. nov.
(8) Nesting in soil under stones or leaves: *M. pastinifera* (Creighton); *Antillaemyrmex albispina* (Wheeler); *terricola* (Mann); *flavidula* (Mann).

No less remarkable than this diversity of nidification is the extraordinary diversity of coloration in the species of Macromischa and Croesomyrmex. They not only exhibit nearly the whole gamut of insect colors from yellow through testaceous, ferruginous, red, brown, and black to metallic green, blue, violet, and purple, but these colors are often so peculiarly distributed on the body and appendages as to suggest some ethological significance in the lives of the insects. The metallic, or most highly evolved type of coloration, occurs only among the Cuban and Bahaman species of Macromischa and in Croesomyrmex. The continental species of the former genus and all the species of Antillaemyrmex have merely a yellow, red, or black coloration, like the great majority of Formicidae.

The peculiar, very largely West Indian distribution of the three closely related genera, Macromischa, Croesomyrmex, and Antillaemyrmex suggests a consideration of their possible phylogenetic and geological history. Emery and Mayr at one time believed that the genus Macromischa was also represented in the Old World. The latter described two species, *M. aculeatus* and *africanus* from the Ethiopian

region, but Emery later relegated them to the genus Tetramorium. In 1922, I placed them in a new genus, Macromischoides. The workers of these species closely resemble Macromischa *sens. str.* and build carton nests somewhat like those of *Macromischa sallei*, but the males have 10–11 instead of 13-jointed antennae and lack the notauli on the mesonotum. More recently (1924) Santschi, though accepting the genus Macromischoides as valid, has placed it in the tribe Tetramorii. Its affinities to Macromischa are, therefore, remote, because the latter is by common consent most closely related to Leptothorax and is even cited by Emery in the "Genera Insectorum" (1924) as the first genus of his tribe Leptothoracini.

Macromischa also closely resembles one of the Old World groups of species in the genus Leptothorax. This group, represented by some eight species and a number of subspecies and varieties, is charactered by an elongate petiolar peduncle and a rounded or depressed petiolar node as in Macromischa, and has a rather singular distribution, comprising the Canary Islands, Morocco, Oran, Algiers, Tunis, Sardinia, Sicily, Italy, the Balkan peninsula, Palestine, Syria and Abyssinia. Four of the eight species occur in the Canary Islands and of these, two have subspecies in Morocco. One highly variable form, *L. rottenbergi*, regarded as the type of the group, was actually described by Emery as a Macromischa. It has a wide distribution over the area above mentioned. This *rottenbergi* group seems, indeed, to be quite distinct from the other groups of Leptothorax. The species are larger and some of them exhibit a more vivid coloration, in both of which characters they approach Macromischa. Concerning the center of distribution of the group, Santschi (1909) says: "This group is unequally distributed throughout the shores of the Mediterranean, the west coast of Morocco, and the Canaries, but it is in these two latter regions that it presents the greatest number of species and varieties. These regions, therefore, may be regarded as the cradle of the group, whence it has radiated toward the east and perhaps towards the south as far as Senegal."

When we turn to the paleontological data we find that species of the *rottenbergi* group of Leptothorax actually ranged as far north as the Baltic region during the Early Tertiary. Mayr (1868) in his admirable monograph on the ants of the Baltic amber described three species of Macromischa (*rudis*, *rugosostriata*, and *petiolata*) and Ernest André later referred a fourth species (*prisca*), somewhat doubtfully, to the same genus. In my revision (1914) of these fossils, I assigned André's species provisionally to the oriental genus Vollenhovia and Mayr's three species to a new genus, Nothomyrmica. But Emery (1921) has not

accepted this interpretation. He regards Mayr's *rugosostriata* and *petiolata* as belonging to the *rottenbergi* group of Leptothorax, and *rudis* Mayr and *intermedia* Wheeler as representing some other Leptothorax group with dubious affinities. Reëxamination of my figures and descriptions leads me to accept Emery's interpretation. Especially, the allocation of *rugosostriata* in the *rottenbergi* group seems to me to admit of no doubt.

We may assume, therefore, that the nearest allies of Macromischa were already developed in northern Europe as early as the Lower Oligocene, and we may derive the Antillean genera Macromischa, Croesomyrmex, and Antillaemyrmex from some offshoot of the circumpolar genus Leptothorax, a large and heterogeneous complex which has also given rise to the present almost entirely continental neotropical subgenus Goniothorax. There is an alternative interpretation, however, namely, that the three neotropical genera Macromischa, Croesomyrmex, and Antillaemyrmex are directly derived from the *rottenbergi* group of Leptothorax, but this would necessitate a resort either to a hypothetical sunken land-bridge between the Mediterranean region and the Antilles, as suggested by Scharff, or to an early geological apposition of the Antillean region and northwest Africa, as postulated by Wegener.

Macromischa sallei (Guérin) subsp. opacinoda subsp. nov.

Worker.— Length 3.5–4.5 mm.

Somewhat smaller and more slender than the typical *sallei* and of the same stature as the subspecies *haytiana* Wheeler and Mann, but differing from this form as follows: epinotal spines shorter and seen from above somewhat curved inward, longitudinal rugae of the head more distinct, thoracic rugosity much finer, less longitudinal and distinctly vermiculate. Petiolar node narrower anteriorly and in profile less rounded; like the postpetiolar node, not shining but opaque or subopaque and regularly reticulate. Head and thorax ferruginous, the former scarcely paler than the latter; petiolar peduncle deep ferruginous, its node and that of the postpetiole dark brown; gaster black, with reddish tip; legs brownish ferruginous, slightly darker than the head and thorax, tarsi paler and more reddish. Antennae ferruginous, paler at the base, the clubs blackish.

Described from numerous specimens taken by Mr. W. T. Eyerdam at Grand Cayamite, Haiti, running on the trunk of a tree.

Macromischa azteca sp. nov.

Worker.— Length 2.6–3 mm.

Head subrectangular, very nearly as broad as long, with subparallel sides, broadly rounded posterior corners and feebly convex posterior border. Eyes rather convex, at the middle of the sides. Mandibles large, 5-toothed, with convex external borders. Clypeus convex in the middle, depressed at the sides, with broadly rounded, entire anterior border. Frontal area indistinct. Antennal scapes surpassing the posterior border of the head by nearly three times their greatest diameter; first funicular joint nearly as long as the four succeeding joints together, joint 2 distinctly longer than broad, 3–8 subequal, as broad as long; club long, 3-jointed, the two basal joints fully $1\frac{1}{2}$ times as long as broad, together equal to the somewhat thicker apical joint. Thorax rather long, broader through the pronotum; the meso- and epinotum parallel-sided; in profile the dorsal outline is straight except for a faint but distinct transverse impression between the meso- and epinotum. Base of epinotum longer than the abrupt, concave declivity; spines as long as the declivity, directed backward and outward and slightly deflected. Petiolar peduncle as long as the node, armed anteroventrally with a slender, downwardly directed spine; node rising rather abruptly from the peduncle, broader than long, anteroposteriorly compressed, with straight, blunt, transverse superior border, the sides straight and converging below. Postpetiole strongly convex anteriorly, from above small, nearly square, slightly narrower anteriorly and distinctly narrower than the superior border of the petiolar node. Gaster of the usual shape; sting long. Legs rather long, tibiae and median portions of the femora distinctly swollen.

Mandibles shining, striate. Head and thorax almost opaque, finely punctate, the head and clypeus also longitudinally rugulose. Thorax above irregularly rugulose, the sides of the pronotum more longitudinally, the epinotal declivity transversely rugulose. Nodes of petiole and postpetiole smooth and shining, their sides and the peduncle of the former punctate and more opaque. Gaster smooth and shining. Antennal scapes subopaque, densely punctate; legs more shining and more densely punctate. Hairs white, bristly, pointed, of uneven length, erect on the body and somewhat sparser than on the appendages, where they are more oblique.

Yellowish ferruginous; mandibles, clypeus, cheeks, gaster and legs somewhat paler and more yellow; teeth and borders of mandibles,

antennal clubs, knees, posterior tibiae and posterior borders of gastric segments brown.

Female (deälated). Length 4 mm.

Resembling the worker except in the shape and sculpture of the thorax. Mesonotum large, flattened above, as broad as long; epinotal spines stout, shorter than their distance apart at the base. Pronotum transversely, mesonotum and scutellum longitudinally, and epinotum irregularly rugulose. Color like that of the worker but with the wing insertions, epinotal spines, petiolar and postpetiolar nodes, femora and tibiae of the middle and hind legs, a broad band at the posterior end of each gastric segment and along the sides of the first, dark brown or blackish. Petiolar peduncle pale yellow; mandibular teeth black. Pilosity on the body more uniform and somewhat more abundant than in the worker.

Male.— Length 2.3–2.5 mm.

Head as broad as long, prolonged and rounded behind the large, prominent eyes, without posterior corners, cheeks very short. Ocelli large, prominent. Mandibles well developed, 4-toothed, with convex external borders. Clypeus very convex in the middle, with straight, transverse anterior border. Antennal scapes short, only four times as long as broad; funiculi long, first joint elongate, swollen; joints 2–7 more slender, subequal, about $1\frac{1}{2}$ times as long as broad; club 4-jointed, the three basal joints subequal, twice as long as broad, the terminal joint as long as the two preceding together. Mesonotum and scutellum shaped much as in the female, the former with distinct but shallow notauli (Mayrian furrows), the epinotum small, unarmed, rectangular in profile, with subequal base and declivity, the former distinctly concave anteriorly. Petiole with thick peduncle, the node in profile low, rising very gradually from the peduncle and only half as long as the segment, seen from above narrow, with straight, transverse superior border. Postpetiole rectangular as in the worker but broader than the petiolar node. Gaster like that of the worker, genitalia prominent. Wings rather short.

Mandibles shining, finely and indistinctly punctate; head opaque, densely and more coarsely punctate; clypeus and sides of front also longitudinally rugulose. Thorax punctate like the head but less densely, so that the surface is more shining, especially on the sides. Remainder of the body smooth and shining, with fine, sparse, piligerous punctures.

Pilosity pale, much finer, shorter and sparser than in the worker and female, and more nearly appressed on the appendages.

Black; mandibles yellowish, with brown teeth; clypeus dark brown; antennae, legs and genitalia pale brown, tarsi paler. Wings whitish hyaline, with very pale brownish veins and stigma.

Described from a number of workers and males and a single female found by Dr. Elisabeth Skwarra nesting in hollow twigs at Mirador, Mexico. This species somewhat resembles *M. affinis* Mann of Cuba, but is smaller, with shorter epinotal spines, differently shaped petiole and postpetiole, different coloration, etc.

Macromischa skwarrae sp. nov.

Worker.— Length 2.6–3.2 mm.

Head subrectangular, slightly longer than broad, as broad in front as behind, its posterior border slightly concave. Eyes moderately large and convex, at the middle of the sides. Mandibles stout and rather broad, with five subequal teeth and rather straight external borders. Clypeus convex, its anterior border broadly rounded and projecting. Frontal area distinct but not impressed. Antennal scapes reaching very nearly to the posterior border of the head; first funicular joint as long as the three succeeding joints together; joints 2–8 as broad as long; club 3-jointed, its two basal joints together somewhat shorter than the more enlarged terminal joint. Thorax rather long, broader through the pronotum, its dorsal profile straight except for a very feeble impression between the meso- and epinotum; base of the latter rounded in profile and nearly twice as long as the sloping concave declivity, armed with two small, blunt, approximated spines, which are somewhat longer than the distance between their bases and directed upward, backward and outward; metasterna large, bluntly angular and turned upward. Petiole rather short, with robust peduncle, armed with a small anteroventral tooth; node low, its anterior surface rising gradually from the peduncle, its posterior surface convex and descending more abruptly to a pronounced constriction of the petiole. Seen from above the node is laterally compressed and but little broader than the peduncle. Postpetiole campanulate, fully $2\frac{1}{2}$ times as broad as the petiole, as long as broad, narrowed and evenly rounded anteriorly, posteriorly with subparallel sides. Gaster lenticular, somewhat flattened dorsoventrally, with straight anterior border. Legs long, femora, especially the hind pair, greatly incrassated.

Mandibles, head, thorax, pedicel, antennae and tibiae opaque, gaster and femora somewhat shining, or lustrous. Mandibles coarsely striate, head, thorax and pedicel densely punctate, clypeus and head

also longitudinally rugulose, thorax covered with more undulating and irregular rugae, which are somewhat less distinctly longitudinal. Gaster and legs finely and densely reticulate.

Hairs on the body white, short, obtuse, erect and rather sparse, mostly on the dorsal surface; short, acute and appressed on the appendages.

Head, scapes, thorax, petiole and postpetiole deep black; gaster dull yellow with a dark brown band at the posterior border of the first segment. Antennal funiculi, mandibles and legs dark brown, almost black.

Female (deälated). Length 5 mm.

Resembling the worker in sculpture, pilosity and color, but the sculpture of the thorax is stronger and more regular, the pronotum and epinotal declivity being transversely, the mesonotum, scutellum and pleurae longitudinally rugulose. Mesonotum as broad as long, flattened above; base and declivity subequal, the latter vertical, the spines in the form of dorsoventrally compressed lobes, less than twice as long as broad, directed backward. Petiole irregularly rugulose; postpetiole fully $1\frac{1}{2}$ times as broad as long, above finely, longitudinally rugulose. Gaster suboblong, more reddish yellow than in the worker, with dark brown bands at the posterior borders of the segments, the one on the first segment being more than twice as broad as the others.

Described from several workers and a single female taken by Dr. Elisabeth Skwarra in an epiphyte (*Tillandsia circinnata*) at Cuernavaca, Morelos, Mexico. This beautiful species is very easily recognized and very unlike the other continental species. It resembles *M. isabellae* Wheeler of Porto Rico in the shape of the thorax and petiole, but is very different in sculpture and coloration.

Macromischa annectens sp. nov.

Worker.— Length about 3.7 mm.

Head subrectangular, slightly broader behind than in front, with broadly rounded posterior corners and nearly straight posterior border. Eyes moderately large and convex, at the middle of the sides. Mandibles rather small and flat, with a large apical and four smaller basal teeth. Clypeus short, convex in the middle behind, its anterior border sinuate in the middle and on each side so that it appears somewhat bilobed. Frontal area triangular, rather indistinct. Frontal carinae short, diverging posteriorly. Antennal scapes reaching to the posterior corners of the head; first funicular joint as long as the three succeeding

joints together; joints 2–7 small, broader than long, 8 as long as broad; the three terminal joints forming a very distinct club, as long as the remainder of the funiculus and with the two basal joints subequal and together shorter than the last joint. Thorax long and narrow, fully three times as long as broad, somewhat broader through the pronotum than through the parallel-sided mesoëpinotum; pleurae flattened; dorsal surface in profile nearly straight and horizontal, without mesoëpinotal impression; base and declivity of epinotum subequal, the latter perpendicular and concave; the spines stout at the base, laterally compressed, with blunt tips, longer than their distance apart at the base, but shorter than the epinotal declivity, directed backward and outward and very slightly curved downward. Peduncle of petiole with a minute anteroventral tooth, nearly as long as the node, which is somewhat cuboidal and constricted behind, in profile with steeply sloping anterior, horizontal superior and perpendicular posterior surface; seen from above, it is as long as broad, semicircularly rounded anteriorly, with straight posterior border. Postpetiole $1\frac{2}{3}$ times as broad as the petiolar node and about $1\frac{1}{2}$ times as broad as long, rounded-trapezoidal, slightly broader behind than in front, convex and rounded above. Gaster rather large, broadly elliptical, first segment with truncated, nearly straight anterior border; sting long. Legs stout; all the femora, and especially the hind pair, conspicuously incrassated in the middle.

Opaque; venter, coxae, legs and antennal scapes feebly shining, or glossy. Mandibles finely longitudinally striated. Clypeus longitudinally rugulose, most distinctly on the sides. Head densely punctate above, longitudinally reticulate-rugose, its sides and the sides of the thorax merely reticulate-rugose, the dorsal surface of the latter longitudinally but more vermiculately rugose, the pronotum much more coarsely than the mesoëpinotum. Epinotal declivity smooth but dull. Petiolar node indistinctly reticulate-rugose above, postpetiole coarsely and densely, and dorsal surface of first gastric segment more distinctly, scapes and legs more finely and indistinctly reticulate or shagreened.

Hairs on the body yellowish, short, stout and obtuse (as in Leptothorax), not very abundant and confined largely to the dorsal surface; pubescence very short and appressed, distinct on the antennae, almost absent on the legs.

Ferruginous red; mandibles, antennae, coxae, legs, petiolar peduncle and terminal gastric segments paler, dull ferruginous yellow; first gastric segment with a poorly defined dark brown fascia posteriorly. Mandibular teeth black.

Described from three specimens taken by Dr. Skwarra at Cuernavaca, Morelos, Mexico, nesting in an air-plant, *Tillandsia circinnata*.

This singular ant somewhat resembles *M. azteca* and *salvini* Forel, but is really very different. In habitus it is so much like certain species of Leptothorax, especially those of the *rottenbergi* group, that I should have placed it in that genus but for its more conspicuously incrassated femora.

Macromischa petiolata (Forel)

This form was originally described as a Leptothorax and based on specimens from a single colony which I took many years ago at Cuernavaca, Morelos, Mexico, nesting in an epiphyte (Tillandsia), which also contained colonies of two other ants belonging to the genera Cryptocerus and Crematogaster. Forel suggested that the species might be a Macromischa, and Emery in the "Genera Insectorum" has recently transferred it to that genus. This allocation is undoubtedly correct.

The deälated female (undescribed) of the colony is still in my collection. It measures 4 mm. and has a broader head than the worker, as broad as long and distinctly narrower in front than behind. Thorax only about twice as long as broad, with large mesonotum, which is as broad as long, semicircular anteriorly and flattened above. Scutellum large and flattened, as long as the epinotum which has a sloping base and vertical declivity; spines very short and blunt, less than twice as long as their basal diameter and shorter than their distance apart. Petiolar node higher, more cuboidal and more distinctly marked off from the peduncle than in the worker. Postpetiole transversely subrectangular, fully twice as broad as long. Gaster large, elliptical, with concave anterior border. Sculpture like that of the worker, but the head, mesonotum and scutellum finely and sharply longitudinally rugulose; metasterna and bases of epinotal spines more coarsely rugulose. Pilosity and coloration as in the worker.

Macromischa flavitarsis Mann

A number of workers, females and males were taken by Dr. Elisabeth Skwarra from several colonies at Mirador, Mexico. One of these was nesting in a thorn of *Acacia cornigera*, the others in the stems of a Melastomaceous shrub, *Conostegia xalapensis*. Females and workers

from another colony taken at Tlacocintlo were nesting in a *Tillandsia pruinosa*. The workers and females agree closely with the types which I collected in hollow twigs in the highlands of Guatemala. The tibiae of the workers are more or less whitish, like the tarsi, at the base, and the tips of the epinotal spines are of the same color. Mann failed to notice that the head of the female is longitudinally rugose like the mesonotum. The tibiae are yellowish or whitish clouded with fuscous. The wings are white, with very pale veins and stigma. Dr. Skwarra's material contains two ergatomorphic females, which are somewhat smaller than the worker, wingless, but with a typical female thorax. The head and mesonotum, however, are smooth and shining as in the worker. The head is shaped like that of the worker but has more prominent eyes, distinct ocelli, and shorter antennal scapes.

Male (undescribed). Length 2.3 mm.

Head as broad as long, with large convex eyes, well developed cheeks, the postocular portion large, distinctly swollen on each side just behind the eyes and projecting backward as a blunt pyramid bearing the moderately large and widely separated ocelli. Clypeus narrow, convex, with rounded, projecting anterior border. Mandibles small, with two distinct apical and two indistinct basal teeth. Antennae with long scapes as in the worker; first funicular joint elongate, swollen; all the remaining joints longer than broad; the club 4-jointed, not sharply marked off from the remainder of the funiculus. Thorax short, mesonotum convex anteriorly, with well developed notauli; mesosterna swollen. Epinotum unarmed, in profile with distinct, subequal base and declivity meeting at an obtuse angle. Petiole with a low node rising gradually from the short, slender peduncle; seen from above, the node is pyriform and as broad as long. Postpetiole transversely elliptical, twice as broad as long and much broader than the petiolar node. Gaster elliptical with truncated base and prominent, exserted genitalia. Legs slender, wings small.

Mandibles, nodes of pedicel and gaster smooth and shining; head, thorax and ventral portions of pedicel subopaque, finely and densely punctate.

Pilosity somewhat as in the worker and female, but the rigid, erect hairs on the dorsal surface are shorter and more delicate.

Black; appendages pale brown or whitish; antennal clubs and femora, except their bases and tips, infuscated; tibiae more feebly infuscated in the middle. Wings pale, whitish, with colorless veins and stigma.

Macromischa subditiva Wheeler

This Texas species closely resembles *M. flavitarsis* Mann and *laevissima* Wheeler of Mexico, but is paler, reddish brown, with shorter and less curved epinotal spines, the petiolar node is broader above with more transverse superior border and sharper lateral corners. Surface of head less smooth and shining, being throughout finely longitudinally rugulose and the thorax smooth, shining and free from sculpture only in the mid-dorsal region of the pronotum.

I have taken this species nesting, like certain species of Leptothorax, in the bark of large trees (willows) at Austin, Del Valle, and New Braunfels, Texas, and have specimens taken by J. A. Mitchell at Victoria and by R. A. Vickery at Harlingen, in the same state. The series from Victoria contains a deälated female which has not been described. It measures 3.5 mm. Head subrectangular, as broad as long, broader behind than in front, with convex posterior border. Thorax less than twice as long as broad, mesonotum nearly as broad as long, flattened above; scutellum nearly as long as the epinotum, which is short, with sloping base and vertical declivity; spines acute, stout at base, shorter than their distance apart. Postpetiole nearly $2\frac{1}{2}$ times as broad as long; gaster large, elliptical, with concave anterior border. Pilosity and coloration as in the worker, head and thorax more opaque, evenly longitudinally rugulose.

Macromischa melanocephala sp. nov.

Worker.— Length 1.5–1.8 mm.

Head subrectangular, slightly longer than broad, with broadly rounded posterior corners and convex posterior border. Eyes rather large, at the middle of the sides. Mandibles with two stout apical and three small basal teeth, external borders rather straight. Clypeus large, moderately convex, its anterior border entire, broadly rounded and projecting. Frontal area distinct, triangular, with a median carinula. Frontal carinae short. Antennae stout, scapes reaching slightly beyond the posterior border of the head; first funicular joint as long as the three succeeding joints; joints 2–8 subequal, distinctly broader than long; club very distinct, 3-jointed, its terminal joint large, longer than the two basal joints together. Thorax short and stout, less than twice as long as broad, broad through the humeri of the pronotum, which is very large; meso- and epinotum narrowed posteriorly. In profile the thorax is high with convex, evenly rounded dorsal outline

and rather long, steep, concave epinotal declivity; spines slender, approximated at the base, as long as the declivity, directed upward, backward and outward and somewhat curved downward. Metasterna small and rounded. Petiole short, the peduncle laterally compressed, without anteroventral tooth; node as long as the peduncle from which it rises abruptly, higher and somewhat broader than long, in profile subcuboidal, from above semicircular. Postpetiole broadly campanulate, fully twice as broad as long and twice as broad as the petiolar node. Gaster rather large, suboval, with straight or slightly concave anterior border. Legs rather short, femora, especially the hind pair, distinctly incrassated.

Mandibles, head, thorax and scapes opaque, remainder of the body somewhat shining, or lustrous, the gaster more than the pedicel and legs. Mandibles finely and indistinctly striated; clypeus longitudinally rugulose; head uniformly and densely punctate, the punctures arranged in regular lines separated by very delicate and rather indistinct rugules. Thorax and pedicel much more finely and densely punctate, in some specimens with indications of fine longitudinal striae on the pronotum. Pedicel finely but more superficially punctate. Gaster and legs smoother, superficially reticulate. Scapes densely punctulate.

Hairs yellowish, sparse, obtuse and erect on the dorsal surface of the body, fine, pointed and appressed on the appendages.

Clypeus and head black; mandibles, frontal carinae, antennae, thorax and abdomen pale brownish yellow; antennal clubs infuscated; legs and epinotal spines white or very pale yellow.

Female (deälated). Length 2–2.3 mm.

Head more rectangular than in the worker, fully as broad as long. Thorax very broad and robust, the mesonotum subrectangular, flattened and longer than the scutellum and epinotum together. Epinotal spines stout, acute, scarcely longer than their distance apart at the base, directed backward and curved somewhat inward and downward. Sculpture, pilosity and coloration of head, pedicel and appendages as in the worker but the mesopleurae, wing insertions, posterior border of scutellum, metanotum, an anteromedian spot on the mesonotum, and elongate spots on the paraptera, dark brown. Gaster dark brown, with only the anal region and the anterior portion of the first segment, both dorsally and ventrally, brownish yellow.

Described from two females and many workers, constituting a single colony collected at Hacienda Jiqui, Ensenada de Cochinos, Cuba, by Dr. J. G. Myers. They were nesting in a dead twig of mahogany (*Swietenia mahagoni*) lying on the ground. This queer little ant is

quite unlike any other known species of the genus. In thoracic structure it resembles the species of Antillaemyrmex, but the petiole is clearly that of a Macromischa.

Macromischa porphyritis Roger

Worker.— Length 4.5–5 mm.

Slender; head suboval, about $\frac{1}{5}$ longer than broad, narrowed behind, with straight posterior border and rather indistinct posterior corners; cheeks rather straight, subparallel. Eyes moderately large and convex, at the middle of the sides. Mandibles narrow, 5-toothed, with rather straight external borders. Clypeus short, convex in the middle, its anterior border feebly sinuate in the middle. Frontal area triangular, distinct, but not deeply impressed. Antennae very slender; scapes reaching fully $\frac{1}{4}$ their length beyond the occipital border; first funicular joint as long as the second and third together, the second distinctly longer than the third, joints 3–7 one and one-half times as long as broad; club rather indistinctly 3-jointed, shorter than the remainder of the funiculus. Thorax long, of uniform width, except for a pronounced lateral constriction between the pro- and mesonotum; dorsal outline in profile straight and horizontal; base of epinotum twice as long as the declivity, with which it forms a right angle; spines long and slender, nearly as long as the base of the epinotum, directed backward and somewhat upward, their bases rather stout, directed outward, backward and somewhat inward; their tips turned upward, so that each spine has a distinct sigmoidal flexure. Metasternal angles very short and blunt. Petiole very long and slender, the peduncle twice as long as the node, distinctly swollen at the spiracles, with a rudimentary anteroventral denticle and a ventral convexity near the middle; node in profile rather low and evenly rounded, longer than high, about twice as long as broad, constricted behind. Postpetiole campanulate, as broad as long, behind nearly twice as broad as the petiole. Gaster slender, its first segment decidedly longer than broad, the remaining segments forming a long, tapering point. Sting well developed. Legs long; femora only slightly incrassated.

Mandibles somewhat shining, coarsely striate-punctate; head and thorax opaque or somewhat lustrous, finely and densely punctate-rugulose, the rugules indistinctly longitudinal on the vertex, pronotum and pleurae, more distinct and transverse on the mesoëpinotum. Petiole, postpetiole, gaster and legs rather shining, sparsely and finely punctate; femora sparsely tuberculate; scape opaque, finely punctate-striate.

Hairs white, pointed, abundant, moderately long and erect on the head, thorax and gaster, somewhat shorter and more oblique on the legs; numerous, conspicuous and curved on the scapes.

Mandibles, clypeus and cheeks anteriorly yellowish red; head and thorax deep, dull metallic purple, often with violaceous reflections; petiole, postpetiole and gaster black, with bluish reflections; legs and antennae more piceous or dark brown; terminal tarsal joints more reddish; sting golden yellow.

Described from numerous specimens taken by Dr. P. J. Bermudez in the Sierra del Grillo, Havana Province, Cuba. Dr. Aguayo has also sent me a single worker taken by Dr. Bermudez at Matanzas, which is very near the locality in which Gundlach took Roger's type specimen. This, I feel certain, is the true *porphyritis*. The only point in which it disagrees with Roger's description is the color of the legs which is described as "gelb-braun." Probably the type specimen was immature. The form taken by Creighton at Soledad, near Cienfuegos, and identified by Mann as *porphyritis* is a very similar but distinct species, which is described below as *M. manni* sp. nov.

Macromischa porphyritis var. latispina var. nov.

Worker. Of the same size and with the same sculpture and pilosity as the typical form of the species, but the head and thorax are dull opaque black, without metallic reflections; the abdomen and appendages also darker and more blackish, the mandibles, clypeus and cheeks more yellowish red as in the type. The basal half of each epinotal spine is conspicuously broader and more laterally compressed, but the dilatation ends rather abruptly at the middle so that the apical half of the spine is thin and tapering and bent downward.

Eleven specimens taken by Dr. C. G. Aguayo at Mena, in the Yurumi Valley, Matanzas, and, therefore, at or very near the type-locality of the true *porphyritis*.

M. porphyritis var. jaumei Santschi

Santschi (1930) described this form from several worker specimens taken by M. Jaume at Ceiba Mocha, Matanzas, as a distinct species, but a cotype specimen kindly sent me by Dr. Aguayo shows that it is really a form of *porphyritis*. The specimen is darker than those described by Santschi, having the head and thorax dull purplish black

instead of deep red. The rugulosity of these parts is distinctly coarser, the petiole and postpetiole less shining. I believe, therefore, that *jaumei* can be only a variety or at most a subspecies of *porphyritis*. Probably Santschi compared his specimens with specimens of *M. manni* which has been erroneously identified as the true *porphyritis*.

Macromischa manni sp. nov.

Worker.— Length 5–5.5 mm.

Similar to *porphyritis* but averaging somewhat larger. Head subrectangular, only slightly longer than broad, distinctly broader behind the eyes than in front, with well developed posterior corners, straight posterior border and very feebly convex cheeks. Mandibles 5-toothed, with distinctly convex external borders. Thorax shaped much as in *porphyritis*, but more robust and the dorsum of the mesoëpinotum very feebly convex; epinotal spines also very similar but slightly shorter, with more slender bases and less pronounced sigmoidal flexure. Petiolar peduncle distinctly stouter, the node higher, more broadly rounded in profile and with more sloping anterior declivity. Postpetiole broader than long and more rounded anteriorly than in *porphyritis*. Femora distinctly more thickened in the middle. Sculpture of the head and thorax resembling that of *porphyritis* but the rugae decidedly stronger and the punctuation between them looser and less distinct, so that the surface is not opaque but distinctly shining. Femora more sharply tuberculate.

Pilosity as abundant as in *porphyritis* but more yellowish and on the scapes shorter and more appressed.

Head and thorax ferruginous red, with faint violet reflections; mandibles, clypeus and cheeks paler and more yellowish; petiole reddish yellow, with the node, postpetiole, legs and antennae yellowish brown, with very faint bluish reflections. Gaster black; bases of femora paler and more reddish.

A series of workers and a single deälated female taken by Dr. W. S. Creighton at Soledad, near Cienfuegos, Cuba. The female has been described by Mann as that of *porphyritis*. Dr. Creighton took several colonies of this ant nesting in crevices of limestone. Their entrances consisted of carton composed of silk and vegetable detritus. He describes the foraging workers as walking with the long-peduncled abdomen elevated above the thorax, giving them "a curious appearance somewhat reminiscent of a person carrying a parasol."

Macromischa myersi sp. nov.

Worker.— Length 4.5–5 mm.

Head subrectangular, somewhat longer than broad, with broadly rounded posterior corners, straight posterior border and subparallel cheeks. Eyes moderately large, at the middle of the sides. Mandibles 5-toothed, with convex external borders. Clypeus rather flat in the middle, with straight, transverse anterior border. Frontal area distinct, triangular. Antennae slender, scapes reaching fully $\frac{1}{3}$ their length beyond the posterior border of the head; all the funicular joints decidedly longer than broad, the first as long as the two succeeding subequal joints together, the club 4-jointed, not very distinct. Thorax shaped as in *M. manni* but somewhat shorter, with a feeble but distinct transverse dorsal impression between the meso- and epinotum, the base of the latter somewhat longer than the abrupt declivity, the spines long, but shorter than in *manni*, straight in profile, rather stout at the base and slender apically, directed backward and upward, seen from above somewhat curved inward basally and bent slightly outward at their tips. Metasternal angles rounded and not projecting. Petiolar peduncle decidedly shorter than in *manni*, not longer than the node, with feeble anteroventral tooth and slight dilatation at the spiracles. Node decidedly higher than in *manni*, higher than long, rising rather abruptly from the peduncle and evenly rounded above. Postpetiole rounded-trapezoidal, narrower in front than behind, broader than long, about $1\frac{1}{2}$ times as broad as the petiole. Gaster elongate elliptical, the first segment longer than the remaining segments together. Femora and tibiae not incrassated.

Sculpture much as in *manni*, but the rugules even coarser especially on the thorax, transverse on the anterior and longitudinal on the posterior portion of the pronotum and on the pleurae, transverse also on the mesonotum and on the base and declivity of the epinotum. Surface of head and thorax moderately shining; pedicel and gaster smooth and more shining; femora shining and sparsely tuberculate, scapes opaque.

Hairs white, much as in *manni*, but of more uneven length on the body; those on the scapes more delicate and less curved.

Head and thorax ferruginous red, with very indistinct metallic purplish reflections; mandibles, clypeus, cheeks and epinotal spines distinctly yellowish, mandibular teeth black, peduncle of petiole reddish yellow, node and postpetiole brown, gaster black, legs and antennae dark brown or blackish, femora not paler at the base.

Described from numerous workers taken by Dr. W. S. Creighton at Mina Carlota, Cumanyagua (type locality) and San Blas, near Cienfuegos, and two workers taken by Dr. J. G. Myers at Buenos Aires, Trinidad Mountains, Cuba. This species may be readily mistaken for *M. manni*, but is distinguished by the very different petiole, the feebly impressed thoracic dorsum, the shorter epinotal spines, the coarser thoracic sculpture, differently colored legs, etc. Dr. Creighton found the colonies nesting in the crevices of limestone cliffs.

Macromischa squamifera Roger

Numerous workers from the following localities in the Trinidad Mountains, Cuba: Mina Carlota (W. M. Mann, Geo. Salt), Buenos Aires (J. G. Myers) and San Blas (W. S. Creighton). These belong to the form described by Dr. Mann as the var. *atrinodis*, but both he and Dr. Creighton now believe that Roger's specimen was somewhat immature and had incompletely pigmented nodes. The variety, therefore, becomes a synonym of the typical form. According to Mann, this beautiful ant "nests in hollow twigs, sometimes in live plants but preferring small ones on the ground, in humid woods."

Croesomyrmex lugens (Roger)

Worker.— Length 5–5.5 mm.

Head suboval, fully $\frac{1}{4}$ longer than broad, produced and semicircular behind where it is narrower than at the anterior border. Eyes rather large, moderately convex, distinctly in front of the middle of the sides. Mandibules stout, with straight external borders, 5-toothed, the two apical teeth stout, the others small and rather indistinct. Clypeus convex in the middle, subcarinate, with broadly rounded, entire anterior border. Frontal area very distinct, elongate triangular, with a median carinula. Frontal carinae well developed and rather long. Antennae long and slender, the scapes reaching fully $\frac{2}{5}$ their length beyond the posterior border of the head, first funicular joint as long as the nearly equal second and third joints together, joints 2–8 subequal, about $1\frac{1}{2}$ times as long as broad, club 3-jointed, terminal shorter than the two basal joints together. Thorax long, narrower than the head, broad through the pronotum and laterally constricted behind it, mesoëpinotum not longer than the pronotum. In profile the thorax is low, its dorsal outline straight in the middle, the anterior end of the pronotum feebly, the epinotum behind more strongly though

evenly rounded. Metasterna broad and rounded, somewhat projecting. Petiole fully five times as long as broad, only slightly widened behind at the node, which is decidedly shorter than the peduncle, laterally compressed and constricted behind, in profile rather low, about as long as high, broadly and evenly rounded above. The peduncle has no anteroventral tooth and is not enlarged at the spiracles. Postpetiole campanulate, convex above, as long as broad, strongly narrowed anteriorly. Gaster small, elongate-elliptical, pointed posteriorly, nearly as high as broad. Sting small. Legs long, the femora but not the tibiae distinctly incrassated.

Mandibles coarsely striated, rather shining. Head, thorax, abdomen and appendages subopaque, densely and evenly punctate, the nodes of the petiole and postpetiole and the abdomen somewhat more shining. Cheeks and clypeus loosely, longitudinally rugulose; thorax longitudinally rugose, most distinctly on the pronotum which has about sixteen regular rugae, which are coarsest on the sides.

Hairs snow white, obtuse, flattened and somewhat scalelike, abundant and covering the whole insect, erect, of even length and distribution on the body, more oblique on the legs and scapes, appressed on the funiculi and tarsi.

Black; mandibles, frontal carinae, insertions of antennae, extreme tips of antennae and terminal tarsal joints reddish brown. Gaster sometimes with bluish or aeneous reflections.

I have redescribed this singular and striking species from several specimens received from Dr. C. G. Aguayo, who is the first to recover it since it was described by Roger in 1863. He collected the specimens in crevices of a limestone cliff at Camoa, in the province of Havana, Cuba, the very locality in which Gundlach found the type. He also sent me two other series, one taken by himself in the Sierra de Anafe, Pinar del Rio, the other by Dr. Bermudez at Mena, in the Valle de Yurumi, near Matanzas.

Croesomyrmex punicans (Roger)

I infer from Roger's description that this species, which has an unarmed epinotum and a mesoëpinotal impression apparently deeper than in *bermudezi* and *poeyi*, is a true Croesomyrmex. It is the largest species in the genus, measuring 7 mm., and was taken by Gundlach on the farallones of Santiago de Cuba and Monte Toro in the mountains of Guantanamo, at the extreme eastern end of the island.

I have already alluded (p. 4) to Emery's interpretation of this ant,

first as an Aphaenogaster and later as a worker Pheidole. In my opinion neither of these allocations can be sustained. Roger may be supposed to have been familiar with Aphaenogaster since he described several species, and no species of the genus has ever been found in the West Indies. *A. relicta* which Mann and I recorded from Haiti has proved to be a Novomessor. Furthermore, the length of *punicans* (7 mm.) is far too great for a Pheidole worker, and a completely unarmed epinotum is very rare in that huge genus. I feel confident that had Emery been familiar with such species of Croesomyrmex as *poeyi* and *bermudezi*, which have the epinotum unarmed and the thoracic dorsum distinctly concave in the middle, he would have adopted Roger's opinion in regard to the generic affinities of *punicans*.[1]

Croesomyrmex iris (Roger)

Worker.— Length 4–4.5 mm.

Head rectangular, about $\frac{1}{5}$ longer than broad, as broad in front as behind, with broadly rounded posterior corners and straight posterior border. Eyes moderately large and convex, a little in front of the middle of the sides. Mandibles rather broad, with moderately convex external borders, two large apical and three smaller, irregular basal teeth. Clypeus convex behind, depressed anteriorly, with broadly rounded, medially sinuate anterior border. Frontal area distinct, elongate-triangular, continued back as a short furrow representing the anterior end of the frontal groove. Antennae slender; scapes extending about $\frac{1}{3}$ their length beyond the posterior border of the head; first funicular joint somewhat longer than 2 and 3 together, joint 2 slightly longer than 3; club 3-jointed. Thorax broadest through the pronotum, with evenly and feebly rounded dorsal outline, nearly straight in the middle. Metasterna small and rounded. Petiole about five times as long as broad, peduncle with a rudimentary anteroventral tooth, node strongly laterally compressed, as long as the peduncle, nearly as long as high, evenly rounded above and constricted behind. Postpetiole campanulate, convex above, as broad as long, about three times as broad behind as at the petiolar node. Gaster small, elongate-elliptical, pointed; sting small. Legs long, femora thin basally, strongly incrassated distally, tibiae only slightly thickened.

Mandibles striate-punctate, shining; clypeus irregularly rugulose; cheeks indistinctly striate, frontal area shining, head opaque, evenly

[1] See postscript, p. 29.

and densely punctate, the posterior corners somewhat smoother and shining. Thorax shining, longitudinally rugose, the rugae stronger on the pronotum, transverse on the epinotum but continuous on each side with the longitudinal rugae of the pleurae. Peduncle and sides of petiolar node longitudinally rugulose; the narrow upper surface of the node, the postpetiole, gaster, coxae and swollen portions of the femora very smooth and shining; the slender bases of the femora, the tibiae and antennal scapes opaque, finely punctate-striate.

Hairs glistening white, obtuse, moderately long and abundant, erect on the body, more oblique on the appendages.

Mandibles, cheeks and clypeus piceous brown; head dull metallic green or purple; thorax metallic green or cupreous; peduncle of petiole yellow, node metallic green; postpetiole metallic purple; gaster, legs and antennae very dark piceous brown or black, terminal tarsal joints brownish.

Redescribed from several workers sent me by Dr. C. G. Aguayo from three Cuban localities, namely: El Guabinacho, Rangel; San Diego de los Baños, and Subida al Rangel, all in the province of Pinar del Rio. The species has not been taken since Gundlach found the type at the entrance to the Yurumi valley, near Matanzas. There is considerable variation in the metallic coloration of the head and thorax. Roger describes his specimen as having the thorax purplish violet, the femora dark metallic green or brown, the tarsi and funiculi paler brown. Santschi (1930) has very recently described a var. *nigripes* of this species from the Sierra de los Organos, Pinar del Rio, with the antennae and legs, excepting the tarsi, black. Since many of my specimens have the antennal scapes and tibiae distinctly brown or black, I am inclined to regard the proposed variety as not worthy of recognition.

C. IRIS var. RUFITHORAX var. nov.

Worker.— Differing from the typical form in coloration, the head being black with only a very indistinct tinge of metallic green, the thorax yellowish red, the entire petiole reddish yellow, the former with a faint tinge of metallic green, the postpetiole black, like the gaster, legs and antennae. The tibiae are smoother and more shining, but the scapes are opaque as in the typical form.

Described from seven workers taken by Dr. C. G. Aguayo at Las Animas, Rangel (type locality), one from Subida al Rangel, and one taken by Dr. Bermudez at Rangel Arriba, all localities in the province of Pinar del Rio.

C. IRIS var. TRISTIS var. nov.

Worker.— Closely resembling the preceding variety but with both the thorax and petiole dull, dark red, and the petiolar node infuscated. Apart from a scarcely perceptible greenish sheen on the posterior portion of the head, there is no trace of metallic coloration.

Two workers taken by G. Natanzen at Guajaebon, Pinar del Rio, and received from Dr. C. G. Aguayo.

CROESOMYRMEX AGUAYOI sp. nov.

Worker.— Length 3–3.5 mm.

Head suboval, distinctly longer than broad, the postocular portion with broadly rounded posterior corners and convex posterior border, the cheeks subparallel. Eyes moderately large and convex, near the middle of the sides. Mandibles rather broad, 5-toothed, with feebly and evenly convex external borders. Clypeus convex posteriorly, impressed in the middle anteriorly, its border broadly sinuate in the middle. Frontal area triangular, deeply impressed, with a median carinula. Antennae slender, scapes extending nearly $\frac{1}{3}$ their length beyond the posterior border of the head; first funicular joint as long as the two following joints together, the second a little longer than the third, the club distinctly 3-jointed. Thorax rather low, broadest through the pronotum, the dorsal outline evenly arched above and curving behind into the epinotum without distinct base and declivity, the meso- and epinotum rather strongly compressed laterally so that they are narrow and somewhat roof-shaped above. Metasternal angles small and bluntly rounded. Petiole short, the peduncle shorter than the node, with a distinct anteroventral tooth; node laterally compressed, in profile rising gradually from the peduncle, evenly rounded above and constricted behind. Seen from above, the node is only slightly broader than the peduncle and has a very narrow, longitudinal superior border. Postpetiole campanulate, convex above, slightly broader than long and nearly three times as broad as the petiole. Gaster broadly elliptical, with straight anterior border; sting small. Legs moderately long, femora strongly incrassated beyond their slender bases; tibiae not enlarged.

Shining throughout; the head, thorax and petiole less than the postpetiole, gaster and femora; scapes opaque and finely punctate-striate. Mandibles coarsely striate; head densely, evenly but not deeply punctate, the cheeks and inner orbits longitudinally rugulose; posterior

corners more shining and finely striated. Thorax rugose, the rugae coarse and longitudinal on the pronotum and sides, finer and more irregular on the dorsal surface of the meso- and epinotum, transverse on the epinotal declivity. Sides of petiolar node rugose, the rugae, which are less coarse than those on the thorax, radiating fanwise backward from the peduncle. Postpetiole, gaster and legs very smooth and shining, with small, sparse, piligerous punctures.

Hairs snow white, delicate, pointed, uneven, moderately numerous and erect on the body, oblique on the appendages.

Uniformly deep metallic blue; mandibles, antennae, tibiae, tarsi, trochanters and tips of femora, dark piceous brown.

Described from nine workers taken by Dr. C. G. Aguayo in the Sierra de la Guira, San Diego de los Baños, Pinar del Rio, nesting in the crevices of limestone cliffs. This exquisite species resembles *C. wheeleri* Mann, but has longer and much more slender antennae, a differently shaped thorax, much more incrassated femora, a different sculpture of the head and thorax and a very different and more pronounced metallic coloration.

C. AGUAYOI var. ARCHERI var. nov.

Worker.— Differing from the typical form in having the head shorter, the frontal area even more distinct and the surface of the posterior half of the head smoother and more shining, owing to the obsolescence of the dense punctures of the typical form of the species.

Nine workers taken by Mr. A. F. Archer in the San Vicente Valley, Viñales, Pinar del Rio, Cuba.

CROESOMYRMEX POEYI (Wheeler)

Four workers taken by Dr. C. G. Aguayo, two at Furnia, Sierra de la Guira, San Diego de los Baños, Pinar del Rio, and two at Subida al Rangel, in the same province. The specimens were nesting in the crevices of limestone cliffs. Mann has redescribed and figured this peculiar species from Viñales. The antennal clubs are 3-jointed. My specimens do not measure more than 4 mm.

CROESOMYRMEX BERMUDEZI sp. nov.

Worker.— Length 4.5–5 mm.

Very closely resembling *C. poeyi* in the shape, sculpture and coloration of the body and the singular incrassation of the femora, but the clubs of the antennae are distinctly 4-jointed, the head is less narrowed

at the occiput and, instead of being smooth and shining as in *poeyi*, is opaque, densely and finely punctate and with dull green reflection. The thorax is more robust, especially in the mesoëpinotal region, more opaque, more finely rugulose and more densely punctate. The entire petiole is red as well as the thorax; the neck more or less infuscated; the dorsal impression of the thorax is slightly shallower. The petiole is five times as long as broad, parallel-sided behind the spiracles, which are prominent, the peduncle is somewhat stouter than in *poeyi* and the node rises from it less abruptly. The postpetiole is distinctly broader in proportion to its length. Erect hairs, especially on the thorax, more abundant, and those on the scapes more oblique.

Described from several workers taken by Dr. C. G. Aguayo at Las Animas, Rangel, Pinar del Rio (type locality), and by Dr. P. J. Bermudez at La Catalina and Galalón, in the same province.

C. BERMUDEZI var. MUTABILIS var. nov.

Worker.— Length 4–4.5 mm.

Differing from the typical form only in its somewhat smaller size, in having the petiole varying from dark red to black, and in lacking the greenish reflection on the head.

Seven workers from the Sierra del Paso Real, Guane, Pinar del Rio (type locality), and a single worker taken by Natanzen at Pan de Guajaibon, also in Pinar del Rio.

ANTILLAEMYRMEX ALBISPINA (Wheeler)

subsp. pallipes Mann.

This form, from Mona Island, off Porto Rico, was regarded by Mann as a variety, but it seems to me to be a well marked subspecies. A worker and a deälated female in my collection measure only 1.5 and 2.6 mm. respectively, whereas the worker and female of the typical *albispina* measure 2–2.5 and 4 mm. In both castes of *pallipes* the legs, antennal scapes and mandibles are yellowish white and the petiolar node is distinctly smooth and shining. The antennal funiculi are slightly brownish.

ANTILLAEMYRMEX FLORIDANUS sp. nov.

Worker.— Length 2.3–2.6 mm.

Head subrectangular, scarcely longer than broad and somewhat narrower in front than behind, with the moderately large and convex eyes at the middle of the sides; posterior border nearly straight, pos-

terior corners broadly rounded. Mandibles rather small, 5-toothed, with feebly convex external borders. Clypeus sharply carinate in the middle, with straight, entire anterior border, sinuate on each side. Frontal area triangular, impressed, rather large but indistinct. Frontal carinae short, diverging posteriorly. Antennae short; scapes stout, curved at the base, reaching to less than half the distance between the eyes and the posterior corners of the head; first funicular joint as long as joints 2–5; joints 2–8 subequal, much broader than long; club 3-jointed, very distinct, as long as the remainder of the funiculus, the large terminal joint longer than the two subequal basal joints together. Thorax short, somewhat more than twice as long as broad, broadest through the pronotum, the sides gradually converging posteriorly, the dorsal outline evenly convex and rounded; declivity of epinotum perpendicular, concave, somewhat longer than the base; spines as long as the declivity, stout basally, with tapering, acute tips, as long as their distance apart at the base, straight or slightly deflected, directed backward, outward and somewhat upward. Petiolar peduncle short and stout, only half as long as the node, with a strong, downwardly directed anteroventral tooth; node large and thick, subcuboidal in profile, its anterior slope forming an obtuse angle with the peduncle, its dorsal surface somewhat flattened, its posterior surface abrupt and nearly perpendicular. Seen from above the node is as broad as long, rounded anteriorly and laterally, and truncated posteriorly. Postpetiole large and convex, broader than the petiole, fully twice as broad as long, with rounded sides. Gaster large, formed very largely of the first segment which is subrectangular, as broad as long, with straight anterior border. Legs short, femora distinctly but not greatly incrassated in the middle; tibiae clavate.

Shining; gaster and legs more so than the remainder of the body; mandibles striate; clypeus longitudinally rugose on the sides; head, thorax, petiole and postpetiole reticulate-rugose, the two latter less sharply than the two former; gaster and legs very smooth, with small, sparse, piligerous punctures. Epinotal spines longitudinally, epinotal declivity transversely rugose.

Hairs whitish, rather numerous on the body, short, erect, bristle-like and blunt but not coarse; antennal scapes, femora and tibiae with sparse, suberect, blunt but more delicate hairs.

Brownish yellow or pale ferruginous; gaster paler; scapes, mandibles and legs still paler, ivory yellow or white, with the knees, apices of tibiae, tarsal joints and articulations of funicular joints reddish. Mandibular teeth black.

Described from numerous specimens taken from the cavities of a small branch of a tree at Paradise Key, Dade County, Florida. The behavior of this ant was so much like that of certain species of Leptothorax that I at first assigned it to that genus. It has all the essential characters of Antillaemyrmex, however, though it differs from all the described forms in its much coarser and reticulate-rugose sculpture.

Postscript

Since this paper was written, Dr. W. S. Creighton has examined the cotypes of *Macromischa punicans* Roger in the Museum of the Philadelphia Academy of Sciences and gives me the following redescription to include in this place. The insect proves to be a true Croesomyrmex.

Croesomyrmex punicans (Roger)

Head (excluding the mandibles) about $\frac{1}{8}$ longer than broad, the sides feebly convex, the occipital angles much rounded, the occiput narrow and flat. Eyes small, circular or subcircular, strongly convex, and situated at the middle of the side of the head. Mandibles with two well developed apical teeth and two or three poorly developed basal teeth. Clypeus moderately projecting, broadly truncate anteriorly with a small median notch in the anterior edge. Frontal carinae narrow and parallel, not diverging behind. Antennal scapes short and stout, barely surpassing the occipital border, only slightly curved at the base, becoming steadily thicker from the base to apex. First funicular joint twice as long as broad, second joint slightly longer than broad, the remaining small joints as broad as long or broader than long, club 3-jointed, the last joint equal in length to the two preceding joints but surpassing them slightly in thickness. Greatest width of the thorax seen from above approximately $\frac{1}{2}$ of the head, the pronotum subcircular, slightly wider than the epinotum and notably wider than the mesonotum, the latter rather strongly constricted anteriorly, gradually diverging posteriorly. Promesonotal suture absent on the dorsum, obsolete on the sides. Mesoëpinotal suture absent. Seen in profile the promesonotum is strongly convex above and much higher than the epinotum to which it descends posteriorly through a steep, straight declivity. Basal face of the epinotum approximately three times as long as the declivity, flat in its anterior two thirds, feebly convex in the posterior third, meeting the short declivity in a rather blunt, though well marked angle. Node of the petiole not marked off

from the peduncle, the two in profile forming a low wedge which is rounded above posteriorly. Posterior peduncle short and very thick. Postpetiole in profile larger than the petiolar node, the dorsum feebly convex anteriorly, more strongly convex behind. Seen from above, the node of the petiole is longitudinally oval, of equal length with the peduncle, with a pair of prominent lateral stigmatic tubercles at their point of junction. Postpetiole from above with a rectangular node and a triangular peduncle, the node very little broader than that of the petiole. Abdomen elongate, elliptical. Femora strongly but evenly incrassated.

Mandibles entirely covered with fine and rather regular striae, with a few sparse interspersed punctures. Cephalic striae coarser but even more regular, slightly diverging on the occiput. Median portion of the clypeus longitudinally striate. The entire head shining. The whole thorax granulose and opaque as is also the peduncle of the petiole; the node of the petiole and the postpetiole irregularly rugose and feebly shining. Abdomen smooth and moderately shining with minute piligerous punctures.

Hairs on the head, thorax and petiolar nodes rather sparse, erect, golden. Those on the scapes, funiculi and tarsi shorter, whiter and much more numerous. Abdomen, femora and tibiae with short but somewhat sparse hairs.

Head and thorax clear red, legs reddish brown, antennae and abdomen piceous brown. The whole insect, particularly the antennae and abdomen, with faint violaceous reflections in certain lights.

Redescribed from two specimens in the Poey collection of the Philadelphia Academy of Natural Sciences. The locality label is simply "Cuba."

Leptothorax sculptiventris Mayr.

This rare ant deserves consideration in connection with the genus Macromischa, to which one might be inclined to assign it. Mayr described it in 1887 from a worker specimen taken in the province of Santa Catharina, Brazil, and placed it with some misgiving in the genus Leptothorax. In 1899 Forel described a form of it as var. *major* from a specimen taken in São Paulo. He seems to have had no doubt about its being a Leptothorax. Emery, in the "Genera Insectorum" (1921), placed the two forms in his section of the subgenus Goniothorax of Leptothorax, with 12-jointed antennae. Several years ago Father T. Borgmeier sent me from Petropolis, Brazil, a specimen which I identified as *L. sculptiventris* but which is evidently a distinct variety that

may be called *borgmeieri* var. nov. It measures fully 4.5 mm. and is, therefore, as large as the var. *major*, but differs from this and the typical form in the coloration of the legs since the tips of the coxae, the trochanters, the bases of the femora and tibiae are yellow, while the remainder of the femora and tibiae are black and the tarsi red. The second to sixth funicular joints are as broad as long, as in the type. The prothorax has a very feeble but distinct tooth at each humeral angle, indicating relationship with Goniothorax. The legs are long and the femora, especially the hind pair, strongly thickened in the middle. The stature, highly differentiated coloration and general habitus of this variety are those of a Macromischa with a short petiolar peduncle, but the pronotal angles, the spines on the peduncle, the shape of the postpetiole and the pilosity are those of a Goniothorax. I am inclined, therefore, to adopt Emery's allocation of *L. sculptiventris*, at least till it is better known.

Known Species of the Three Genera

Macromischa (Roger) Mann emend.

allardycei Mann (1920) ☿ ♀ ..... Bahamas
affinis Mann (1920) ☿ ..... Cuba
androsana Wheeler (1905) ☿ ..... Bahamas
annectens sp. nov. ☿ ..... Mexico
azteca sp. nov. ☿ ♀ ♂ ..... Mexico
bruneri Mann (1924) ☿ ..... Cuba
creightoni Mann (1929) ☿ ♀ ..... Cuba (Isle of Pines)
flavitarsis Mann (1920) ☿ ♀ ♂ ..... Guatemala
fuscata Mann (1920) ☿ ..... Guatemala
isabellae Wheeler (1908) ☿ ♀ ♂ ..... Porto Rico
laevissima Wheeler (1911) ☿ ..... Mexico
lucayensis Forel (1901) ♀ ..... Bahamas
manni sp. nov. ☿ ..... Cuba
melanocephala sp. nov. ☿ ♀ ..... Cuba
myersi sp. nov. ☿ ♀ ..... Cuba
pastinifera Emery (1894) ☿ ♀ ♂ ..... Bahamas, Cuba
var. *opaeipes* Wheeler (1905) ♀ ..... Bahamas
petiolatus (Forel) (1901) ☿ ♀ ..... Mexico
porphyritis Roger (1863) ☿ ..... Cuba
var. *latispina* var. nov. ☿ ..... Cuba
var. *jaumei* Santschi ☿ ..... Cuba

purpurata Roger (1863) ☿ ♀ ..... Cuba
sallei (Guérin) ☿ ♀ ♂ ..... Santo Domingo
subsp. *haytiana* Wheeler & Mann (1914) ☿ ♀ ♂ Haiti
subsp. *opacinoda* subsp. nov. ☿ ..... Haiti
salvini Forel (1899–1900) ☿ ..... Panama
var. *obscurior* Forel ☿ ..... Panama
scabripes Mann (1920) ☿ ..... Cuba
schwarzi Mann (1920) ☿ ..... Cuba
skwarrae sp. nov. ☿ ♀ ..... Mexico
splendens Wheeler (1905) ☿ ♀ ♂ ..... Bahamas
squamifera Roger (1863) ☿ ..... Cuba
subditiva Wheeler (1903) ☿ ♀ ..... Texas
violacea Mann (1924) ☿ ..... Cuba

Croesomyrmex Mann

aguayoi sp. nov. ☿ ..... Cuba
var. *archeri* var. nov. ☿ ..... Cuba
bermudezi sp. nov. ☿ ..... Cuba
var. *mutabilis* var. nov. ☿ ..... Cuba
gundlachi (Wheeler) (1913) ☿ ..... Cuba
iris (Roger) (1863) ☿ ..... Cuba
var. *rufithorax* var. nov. ☿ ..... Cuba
var. *tristis* var. nov. ☿ ..... Cuba
lugens (Roger) (1863) ☿ ..... Cuba
poeyi (Wheeler) (1913) ☿ ..... Cuba
punicans (Roger) (1863) ☿ ..... Cuba
versicolor (Roger) (1863) ☿ ♀ ..... Cuba (Isle of Pines)
wheeleri Mann (1920) ☿ ♀ ..... Cuba

Antillaemyrmex Mann

albispina (Wheeler) (1908) ☿ ♀ ..... Culebra and
subsp. *pallipes* Mann (1920) ☿ ♀ ..... Mona Isl. near Porto Rico
ciferrii Menozzi (1930) ☿ ..... Santo Domingo
flavidulus Wheeler & Mann (1914) ☿ ..... Haiti
floridanus sp. nov. ☿ ..... Florida
pulchellus Emery (1894) ☿ ♀ ..... St. Thomas
terricola Mann (1920) ☿ ♀ ..... Cuba

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AT HARVARD COLLEGE

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ON THE GENUS ANOSTOMUS (FAMILY CHARACINIDAE)

By N. A. Borodin

With Four Plates

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No. 2.— *On the genus Anostomus (Family Characinidae)*

By N. A. Borodin

The position of the genus *Anostomus* in the general classification of the characin fishes is still uncertain. This is due to the as yet incomplete study of the various collections of fishes belonging to this genus.

Günther classed it as a genus of Characinidae in a group *Anostomatina*, and gave a diagnosis of eight species. Together with *Anostomus*, Günther's group includes *Leporinus* and *Rhytiodus*, while *Curimatus* and *Prochilodus* were placed in a separate group *Curimatina* (Cat. British Mus. Fishes, 1864, **5**, pp. 279, 303–305).

Garman divided the genus into three subgenera — *Anostomus* Gronow, *Schizodontopsis* Garman and *Schizodon* Agassiz, and described five new species (Bull. Essex Inst., **23**, 1890, p. 15).

Boulenger formed a subfamily *Anostominae*, in which he included, besides *Anostomus*, *Leporinus* and *Characidium*, but not *Prochilodus* and *Curimatus* which were included in a subfamily, *Citharininae* (Fishes, Cambridge Nat. Hist., 1904, p. 575–76).

Eigenmann retained Günther's name *Anostomatina* (Rept. Princeton Univ. Exped. to Patagonia, 1909, p. 254).

Regan introduced a family *Anostomidae*, including in it the genera *Anostomus*, *Curimatus* and *Prochilodus*, so that this new family corresponds neither with Boulenger's subfamily *Anostominae* (Ann. Mag. Nat. Hist., ser. 8, 1911, p. 8) nor with the Günther-Eigenmann group of *Anostomatina*.

Eigenmann in his later voluminous work "American Characidae" (Mem. Mus. Comp. Zoöl., **43**, 1917, p. 30) gives a synopsis of groups or subfamilies of the family *Characidae*, in which a group "*Anostomatina*" (p. 28) is again found. Speaking of the classification proposed by Regan, he accepts some of the latter's criticisms on his own classification of the characin fishes, with the reservation, however, that he "postpones the discussion of the general classification of the Characins, until his study of all the subfamilies is completed." This completion, unfortunately, did not take place, because of his death.

Jordan in his "Classification of Families of Fishes" recognizes a separate family *Anostomidae*, which includes the genera *Leporinus*, *Curimatus*, *Prochilodus*, *Anodus*, *Rhytiodus* and many related genera. To the family name he adds, in a parenthesis, *Curimatidae*, *Anodontidae* as synonyms.[1]

[1] D. Jordan. A Classification of Fishes, 1923.

Thus there is not only difference of opinion among ichthyological authorities on the place and relationship of the genus *Anostomus*, but there is not even agreement on the spelling of the proposed family or subfamily to which this particular genus belongs.

My own view on the question of the classification of these fishes makes it preferable, I think, to stick as far as possible to the family names established long ago and introduced in every textbook, and within these families to arrange genera in subfamilies. By doing so, the principal family relationship remains clear for everybody, and confusion will be avoided. At some later date, after a study of much more material than is now available to any one person, a new system may be desirable.

With regard to the particular case of the genus *Anostomus*, I think it would be better to leave it, as it is, a single genus, admitting in a synopsis of species their division into subgenera and forming, together with related genera — *Leporinus*, *Leporellus*, *Curimatus*, *Prochilodus*, *Rhytiodus*, *Anodus* and *Chaenotropus* — a subfamily *Anostominae* of the family *Characinidae*.

The name of the Characin family itself is now often spelled in two ways, *Characinidae* or *Characidae*. In Jordan's "Classification of Fishes," these are considered as "synonyms," the name *Characidae* being put in parentheses. The first spelling originated from the name given to the characin fish *Characinus* by Linnaeus in 1758, and endorsed by Lacépède in 1803 and Cuvier in 1817. The second spelling comes from the name Charax, introduced later by Gronow in 1763 and endorsed by Scopoli in 1777. The spelling *Characinidae* consequently has priority.

As mentioned above, Garman gave a synopsis of the genus *Anostomus*, suggesting its division into three subgenera: *Anostomus*, *Schizodontopsis* and *Schizodon*. This classification of the genus is followed by Eigenmann in his "Freshwater Fishes of British Guiana," with the one difference that Garman's subgenera become genera. On the other hand, in his other paper (see above), he introduced a genus (or subgenus) *Lahilliella*, giving this name to a fish described by Kner as *Anostomus nasutus*, while Garman in the paper cited included *A. nasutus* in the subgenus *Schizodon*. Garman's paper was based on the Thayer collection of Brazilian fishes in this museum.

When rearranging the genera and species of the *Characinidae*, I made a close study of the entire collection of the genus *Anostomus*, reëxamined Garman's types of his new species, and examined all specimens as yet unidentified or labeled with names never published

and described. This study, therefore, presents additional data on the genus *Anostomus*, including a new synopsis of the species, with illustrations of the four subgenera proposed by Garman and Eigenmann, the description of two new species, and a redescription of some of the old species, based on the material in this collection.

Anostomus

Anostomus Gronow, Mus. Ichth., **2**, no. 165, 1756, p. 78, pl. 7, fig. 2; also Zoöphyl., 1763, p. 122, pl. 7, fig. 2; (type) *Salmo anostomus* Linné, 1758; *Anostomus anostomus* Walbaum, 1792.

Schizodon Agassiz, Sel. gen. et species, 1829, p. 66.

Nanagnathus Boulenger, Bull. Mus. Zoöl. et Anat., Comp. Univ. di Torino, **10**, 1895, p. 2.

Pithecocharax Fowler, Proc. Acad. Nat. Sci. Phila., 1906, p. 319.

Anostomus, Schizodon, Lahilliella Eigenmann, Cat. Freshwater Fishes of Americas, Rep. Princeton Univ. Exp. to Patagonia, pt. 2, 1910, p. 425.

Generic characters.— Body elongate, compressed, rounded on back and belly (with the exception of *A. rostratus* Borodin). Head flattish or slightly convex; interorbital space wide; nostrils not remote; the anterior smaller, with a short tube; posterior elliptical, large, wide open. Eyes lateral. Mouth small; its position varies much with the species. Teeth in single series on intermaxillary and mandible, eight on each; fixed, flattened, cuspidate on the edge, at least on one of the jaws. Branchiostegal rays few; branchial membranes not free from the isthmus; scales on body moderate, firmly fixed, striated; head naked. There are feather-like, pointed leather flaps above the ventral fins.

The genus *Anostomus* was described, with a figure of the type, by Gronow in 1756. Linné listed this fish in his "Systema" under the name *Salmo anostomus* (1758). Walbaum defined this genus as it is accepted today, and named its type *A. anostomus*. About twenty species are now included, which form a compact group from the point of view of relationships, though they exhibit sufficient diversities to render the formation of several subgenera desirable. Three subgenera, *Anostomus, Schizodon* and *Schizodontopsis*, proposed by Garman in the paper cited, and a fourth, *Lahilliella* Eigenmann are here recognized. Their diagnostic characters are as follows:

Snout elongate, narrow, subcircular in cross section. Mouth cleft directed straight upward. Upper and lower teeth with minute cusps.
Anostomus, p. 40

Snout broad, short, subelliptical in cross section. Mouth cleft directed obliquely upward or forward. Upper and lower teeth with well defined cusps.
Schizodon, p. 42

Mouth cleft directed obliquely up and forward. Upper teeth cuspidate, lower truncate ..... *Schizondontopsis*, p. 45

Snout narrow, blunt, above the mouth. Mouth cleft directed obliquely down and forward. Upper and lower teeth cuspidate ..... *Lahilliella*, p. 49

ANOSTOMUS Gronow

Anostomus anostomus (Linné)

Salmo anostomus Linné, Syst. Nat., **1**, 1758, p. 312; Syst. Nat., **1**, 1766, p. 514; Bonnaterre, Tableau Enc. Meth. Ichth., 1788, p. 170, fig. 287.

Anostomus anostomus Walbaum, in Artedi, Genera piscium, 1792, p. 659; Cuvier, Regne Anim., **2**, 1817, p. 165; Eigenmann, Mem. Carn. Mus., **5**, 1912, p. 294, pls. 40–41.

Leporinus anostomus Cuvier et Valenciennes, Poissons, **22**, 1849, p. 38.

Anostomus salmoneus Gray, Gronov. Syst., 1854, p. 153; Günther, Cat., **5**, 1864, p. 303; Garman, Bull. Essex Inst., **22**, 1890, p. 17.

Pithecocharax anostomus Fowler, Proc. Acad. Nat. Sci., Phila., 1906, p. 319.

Specific characters.— Head elongated, ending in a long narrow snout, blunt at the end. Cleft of the mouth vertical, opening upward. Teeth on the upper jaw three, bicuspidate, but the cusps are very fine; on the lower jaw, subtruncate, with faint notches only.

D. 11; A. 10; V. 9; L. 1. 39; trans. 4/3; teeth 8/8.

Description of a single specimen in the Museum of Comparative Zoölogy collection, No. 29,921, from Essequibo, British Guiana, 100 mm. long.

Body subfusiform, back and belly rounded, depressed to subquadrate in cross-section near the head, and narrowly compressed in the posterior portion. Depth of the body five times in length. Head long, $4\frac{1}{3}$ in body. Forehead concave longitudinally. Eye large, lateral, $3\frac{2}{3}$ times in head, $1\frac{1}{2}$ in snout. Snout elongate, blunt at the end; chin vertical. Mouth small, superior, cleft vertical, opening upward. Nostrils not widely separated, the anterior with a small tube.

Fins small, short; dorsal origin in mid-length from back to caudal; upper outline convex; anal subtruncate, hardly reaching base of caudal rays. Pectoral reaching little more than halfway to the ventrals.

Scales large, smooth to the touch, membranous on free edges. One narrow band, yellow to reddish in life, brown in alcoholic specimens, runs from the snout over the nostrils, above the eye, and above the lateral line to the base of the caudal; another from the chin below the

lateral line to the base of caudal, and a third, less distinct and narrower, from the interorbital region along the outer edge of the dorsal row of scales to the adipose, gradually vanishing on the end. The colors in life are well reproduced in Eigenmann's work on "Freshwater Fishes of British Guiana" (plate **11**).

This ancestral species of the genus shows the principal character of anostomoid fishes, embodied in the name, which means mouth directed straight upward.

The following species must also be included in the subgenus *Anostomus: Anostomus trimaculatus* (Kner). It might, perhaps, be considered as the most typical member of the subgenus, as its characters are the most generalized. A drawing of this fish (plate **1**) and a short description are consequently given.

Anostomus trimaculatus (Kner)

Plate **1**

Schizodon trimaculatus Kner, Sitzber. Akad. Wien, **30**, 1858, p. 78, and Denkschrift. Akad. Wien, **17**, 1859, p. 161, pl. 6, fig. 12.

Anostomus trimaculatus Günther, Cat., **5**, 1864, p. 304; Garman, Bull. Essex Inst., **22**, 1891, p. 17; Pellegrin, Bull. Mus. d'Hist. Nat., **5**, 1899, p. 406; Eigenmann, Freshwater Fishes of British Guiana, Mem. Carnegie Mus., **5**, 1912, p. 205.

Pithecocharax trimaculatus Fowler, Proc. Acad. Nat. Sci. Phila., 1906, p. 320.

Specific characters.— Mouth directed upward, lower jaw much longer; teeth on lower jaw long, narrow, bi- and tricusped; flanks with two, sometimes three black spots.

D. 13; A. 11; V. 9; L. 1. 44; trans. 1. 6/5; teeth 8/8.

Description.— Based mostly on the examination of specimens Museum of Comparative Zoölogy, No. 20,444 from Obidos, Brazil, 68 mm. long, from which the accompanying drawing was prepared, and No. 19,399 from Gurupa, Brazil, 140 mm. long.

Body comparatively high, depth $3\frac{2}{3}$–4 times in body. Back strongly arched from head to dorsal. Head of medium size, 4–$4\frac{1}{4}$ in body. Mouth small, cleft vertical, lips thick, papillose. Teeth eight on each jaw — upper 4-cusped, lower in front 2-cusped, on sides 3-cusped. Br. rays 3, attachment of membrane to the isthmus rather narrow.

Fins all rounded at the apices. Dorsal near midway from end of snout to caudal. Caudal moderately notched, lobes rounded at ends. Anal not reaching halfway from its base to the short caudal rays.

Pectorals small, reaching little more than halfway from their base to ventrals. Scales thick, firm, appearing as if granulated on the surface. Bases of scales darker, forming vittae anteriorly in anterior half of body.

A diffused spot of black at end of lateral line; another below the middle of base of dorsal on the lateral line. A third spot on the cheek. Many narrow bands can be observed on the back of a younger specimen, such as No. 20,444, 80 mm. long.

There are three more species of Anostomus, belonging apparently to this subgenus: *A. gracilis* Kner, *A. atrianalis* (Pellegrin) and *A. plicatus* Eigenmann, which, however, are not represented in the Museum of Comparative Zoölogy collection.

SCHIZODON Agassiz

Schizodon fasciatus Agassiz

Anostomus fasciatus (Agassiz)

Plate **2**

Schizodon fasciatus Agassiz, Selecta Gen. et Species Piscium, 1829, p. 66, pl. 36; Schomburgh, Fishes Guiana, **1**, 1841, p. 252, pl. 26; Müller and Troschel, Horae Ichthyol., **1**, 1845, p. 10, pl. 1, fig. 5.

Piabuca schizodon Cuvier et Valenciennes, Poissons, **22**, 1849, p. 112.

Anostomus fasciatus Günther, Cat., **5**, 1864, p. 304; Garman, Bull. Essex Inst., **22**, 1890, p. 21; Eigenmann, Mem. Carnegie Mus., **5**, 1912, p. 297.

Specific characters.— Mouth directed forward; lower teeth short, broad, 4-cusped; four dark bands on flanks and a caudal spot.

D. 12; A. 10; V. 9; L. 1.45; trans. 1. 4/4; teeth 8/8.

Description.— Based mostly on Museum Comparative Zoölogy No. 20,462, 79 mm. long, from Hyavary, Brazil, from which the drawing has been prepared.

Depth and head, 4 in body. Eye, 3 in head. Snout blunt. Mouth small, anterior, the cleft rising forward. Lower lip papillose. Teeth, eight above and eight below, 4-cusped. There are three long and one short cusp in adults, but in the young only two front pairs on upper and lower jaw 4-cusped, the others tricusped. Back and flanks brown, belly lighter. Sides with four dark blotches and a spot at end of lateral line, another (faint) on opercle.

The dark blotches in this species vary from faint spots along the lateral line, occurring mostly in young specimens, to regular cross

bands, sometimes even circling the body. Such bands occur in specimens 100 mm. long, and particularly in adult specimens 145–150 mm. long; but there are also some adult specimens which are spotless, as, for instance, those from Manacauru, No. 19,360.

This species is represented in the Museum of Comparative Zoölogy collection by a great many specimens collected by the Thayer Expedition to Brazil in 1865, from the following localities:

No. 20,462	Hyavary	young	1 specimen
19,855	Santarem	young	1
19,483	Teffé	young	1
19,606	Hyavary	young	1
19,336, 19,338	Lake Hyanuary	adult	6
19,351–52	Hyavary	adult	3
19,353	José Fernandez	adult	2
19,377	Manaos	adult	1
810	"Brazil"	adult	2
19,388	Obidos	adult	1
19,363, 19,364	Sao Paulo	adult	1
19,360	Manachuru		12
19,369	Silva Lake Saruca	most of them adults	2
19,332	Coary		2
19,343	Jonantins		1
19,326–27	Teffé		4
19,356	Tabatinga		2
19,329	Villa Bella	adult	26
19,365	Içа	adult	3
19,345	Jutahy	adult	2
19,353	Hyavary	adult	1
19,368	Serpa	adult	2
851	Dutch Guiana	adult	1
19,371–72	Lago Alexo, Brazil	adult	2
19,357	Santarem	adult	1

Besides *A. fasciatus* the following species were included by Garman in the subgenus *Schizodon: A. vittatus* (Cuvier et Valenciennes), *A. isognathus* (Kner), *A. dissimilis* Garman and *A. platae* Garman.

A. vittatus (Cuvier and Valenciennes)

Piabuca vittata Cuvier et Valenciennes, Poissons, **22**, 1849, p. 115; Castelnau, An. Nom. Amer. Sud, Poissons, 1855, p. 64, pl. 32, fig. 1.
Anostomus cittatus Günther, Cat., **5**, 1864, p. 303.

Specific characters.— Depth $3\frac{1}{5}$; head $4\frac{2}{3}$ times in body. Four dark bands on flanks, the posterior one extending back and joining caudal spot. Middle of scales lighter in color, forming longitudinal stripes (vittae) on each row.

D. 12; A. 11; V. 9; L. 1. 43; trans. 4/4; teeth 8/8, 4-cusped on each jaw.

This species is represented in the Museum of Comparative Zoölogy collection by the following specimens from Brazil.

No. 19,391	from Goyaz	adult	5 specimens
19,391a		adult	1
30,915		adult	2
19,385–86	Porto do Moz	2 adult, 3 medium, 1 young	6
19,400a	Cudajas	adult	18

ANOSTOMUS ISOGNATHUS (Kner)

Schizodon isognathus Kner, Sitzb. Akad. Wien, **30**, 1858, p. 78, and Denkschr. Akad. Wien, **17**, 1859, p. 163, pl. 6, fig. 13.

Anostomus isognathus Günther, Cat., **5**, 1864, p. 305; Garman, Bull. Essex Inst., **22**, 1890, p. 22.

Anostomus knerii Steindachner, 1875, Sitzb. Akad. Wien, **71**, p. 1, pl. 1.

Specific characters.— Depth $3\frac{2}{3}$, head $4\frac{1}{5}$. No transverse bands, a dark longitudinal stripe along the lateral line.

D. 11–12; A. 10–11; L. 1. 44–46; trans. 1. 6/5; teeth 8/8, frontal 4-cusped, hindmost 3-cusped.

This species is represented in the Museum of Comparative Zoölogy collection by a single specimen, No. 19,350, adult, 230 mm. long, and collected by the Thayer Expedition in Rio das Velhas, Brazil. Dark longitudinal stripe absent (may be faded); only a caudal spot.

ANOSTOMUS DISSIMILIS Garman

Anostomus dissimilis Garman, Bull. Essex Inst., **22**, 1890, p. 22.

Specific characters.— Depth $4\frac{2}{3}$; head $4\frac{2}{3}$. Eye 4 in head. Transverse bands, if present, blotch-like; no caudal spot.

D. 12; A. 11; V. 9; L. 1. 43–45; trans. 1. 4/5; teeth 8/8, on both jaws 4-cusped.

M. C. Z. No. 19,381 — 8 specimens 19,382 — 2 specimens 19,383 — 1 specimen 19,384 — 1 specimen	From Rio Poty, Brazil. Size from 150–260 mm.

Anostomus platae Garman

Anostomus platae Garman, Bull. Essex Inst., **22**, 1890, p. 23.

Specific characters.— Depth $3\frac{2}{5}$, head $4\frac{2}{3}$ in length to base of caudal, no transverse bands, a faint spot of dark at end of lateral line which has now, however, disappeared.

D. 12; A. 11; V. 9; L. 1. 45; trans. 1. 5/4–5; teeth 8/8, 4-cusped.

M. C. Z. No. 833, a single specimen, 170 mm. long (adult) from Rosario, Argentina, coll. by Capt. S. G. Brooks.

SCHIZODONTOPSIS Garman

Anostomus taeniatus (Kner)

Plate **3**, fig. 1

Schizodon taeniatus Kner, Sitzb. Akad. Wien, **30**, 1858, p. 6 and Denkschr. Akad. Wien, **17**, 1859, p. 23, pl. 5, fig. 10.

Anostomus taeniatus Günther, Cat., **5**, 1864, p. 305; Garman, Bull. Essex Inst., **22**, 1890, pp. 18, 22. The subgenus *Schizodontopsis* proposed in this paper.

Specific characters.— Lower teeth broad, truncate or chisel-shaped; a band along the flank.

D. 11; A. 10; V. 10; L. 1. 43–44; trans. 1. 5/4; teeth 8/8.

M. C. Z. No. 19,373, 19,347	from Lago Alexo, Cudajas, Brazil	2 specimens	1 young, 1 medium
19,384	Lake Hyanuary, Brazil	4 specimens	1 adult, 3 medium
19,384a	Jutahy, Brazil	1 specimen	young

To this subgenus belong the following additional species: *A. proximus* Garman, *A. varius* Garman, *A. nitens* Garman, *A. borelli* Boulenger, *A. orinocensis* Steindachner, *A. laticeps* Eigenmann and *A. garmani* new species.

The types of the three species described by Garman, belonging to this subgenus, are in the collection of the Museum of Comparative Zoölogy. I have reëxamined them to determine their validity and have compared specimens of about the same size. There are specimens 170–190 mm. long (the majority about 170 mm. long) of the species *A. varius* (No. 19,335); *A. nitens* (No. 19,367); *A. proximus* (No. 19,911); *A. dissimilis* (No. 19,381) and *A. platae* (No. 833).

The résumé of the results is as follows:

Body — highest in *A. platae* and *A. dissimilis.*
lowest in *A. varius* and *A. proximus.*

Head — longest in *A. varius.*
shortest in *A. proximus* and *A. platae.*

Eye — largest in *A. proximus.*

Scales — largest in *A. dissimilis* and *A. platae.*
smallest in *A. proximus.*

Lower jaw — greatly projecting in *A. proximus*; almost equal with upper or slightly projecting in all the others.

Mouth — almost terminal in *A. dissimilis.*
oblique and slightly upward in all others; most pronounced in *A. varius.*

Teeth — cuspidate on both jaws, 8/8 in number and equal (*A. platae*).
longer on lower jaw (*A. dissimilis*).
slightly crenulate on the upper and truncate on the lower (*A. varius* and *A. proximus*).

This short analysis, and comparison with the other old species, shows that Garman's new species are valid. The nearest allied are *A. varius* and *A. proximus,* because of their exterior form and coloration. *A. dissimilis* differs from all the others by its cross bands.

For the sake of completeness, I give below the characters of all four species, with a list of the specimens, represented in the Museum of Comparative Zoölogy collection.

Anostomus varius Garman

Specific characters.— Depth $4\frac{1}{3}$, head $4\frac{1}{3}$. Lower teeth truncate or chisel-shaped; a band along the flank and four transverse bands.

D. 12–13; A. 11–12; L. 1. 45–48; trans. 6/5 (6); teeth 8/8.

M. C. Z. No. 19,335	from Lake Hyavary, Brazil (types)	6 adult 1 young	most of them 190 mm. long
19378	José Fernandez, Brazil	6 young	97–100 mm. long
19,398	José Fernandez, Brazil	6 specimens	95–132 mm. long
19,340	Gurupa, Brazil	3 specimens	medium, about 100 mm.
19,374	Rio Nigro, Brazil	adult	180–190 mm. long
19,341	Porto do Moz, Brazil		
809	Manaos, Brazil		
19,532	Obidos, Brazil		smallest 60 mm.
19,348	Obidos, Brazil	2 young	97–100 mm. long

Anostomus nitens Garman

Under this name Garman (loc. cit., p. 20) described a variety of *A. varius* Garman, but after a closer examination of ten specimens in the collection of the Museum of Comparative Zoölogy, I am convinced that it should rightly be ranked as a species.

Specific characters.— Depth 5, head $4\frac{1}{2}$; eye large, 3 in head. Transverse bands reduced to blotches. Coloration light.

D. 12; A. 11; V. 9; L. 1. 45–47; trans. 1. 6/6(7); teeth 8/8, upper 4-cusped, lower truncate.

M. C. Z. No. 19,367 from Içа, Brazil, 10 specimens from 83 to 172 mm. long. Type specimen 95 mm. long.

No. 19,367a from Hyavary, Brazil, with somewhat higher body. This species, being closely related to *A. varius*, differs from it by a more slender body and lighter coloration.

Anostomus proximus Garman

Anostomus proximus Garman, Bull. Essex Inst., **22**, 1890, p. 19.

Specific characters.— Depth $4\frac{1}{2}$; head $4\frac{1}{2}$; eye 4 in head. A band along the flank, no transverse bands.

D. 12–13; A. 10–11; V. 9; L. 1. 45–46; trans. 1. 6/5; teeth $\frac{8\text{–}4 \text{ cusped}}{8 \text{ truncate}}$.

M. C. Z. No. 19,331	from Villa Bella, Brazil, (type)	2 specimens	138 and 175 mm. long
19,379	Lake Hyanuary, Brazil	4 specimens	medium size 90 mm., young
19,911	Içа, Brazil	1 specimen	60 mm., young
19,977	Gurupa, Brazil	1 specimen	60 mm., young

Anostomus garmani spec. nov.

Plate **4**, fig. 1

Specific characters.— Depth 4.7, head 4.7, eye, horizontal diameter 5, vertical 3, 6 in head. Snout 3. Scales large. Coloration dusky, a black longitudinal band sharply expressed, $1\frac{1}{2}$ scales broad, extending all along the body beginning from the head, ending on the root of central rays of the caudal.

D. I, 11; A. II, 8; V. 9; L. 1. 42–43; trans. 1. 4/4; teeth $\frac{8\ 4\text{–}3 \text{ cusped}}{8 \text{ finely crenulate}}$.

Description.— Type specimen, No. 19,370, 170 mm. long, from Silva Lake, Saraca, Brazil, collected by the Thayer Expedition.

Depth 37 mm., head 36 mm.; snout 12 mm.; eye, horizontal diameter (part covered) 7 mm., vertical diameter 7 mm. Distance between eyes 2 in head length. Lower jaw much produced, head flat, mouth directed partly upwards.

42–43 scales in lateral line, 4+1+4 in transverse 1. Dorsal fin as high as the body is deep on the vertical line behind its last ray. Teeth $\frac{6 \text{ (2 broken)}}{6 \text{ (2 broken)}}$.

Gill membrane closely joined to isthmus.

Coloration.— Dusky in the whole body, with a broad black longitudinal band running from the head to the root of caudal and continuing partly on the roots of rays of the caudal fin. This band remained well defined even on the specimens in alcohol sixty-four years (Thayer Expedition), while on specimens of *A. taeniatus* of the same date, the band is almost faded and the fins are colorless. The fins are dusky in *A. garmani*, anal almost blackish, the scales strongly pigmented with blackish.

This new species is very near *A. taeniatus*, but differs from it by having larger and fewer scales (42–43 in 1.1. instead of 44–45, and 4/4 in transverse series instead of 5/6), and more distinct dark coloration in longitudinal band, fins and even scales.

Besides the types, there are in the collection of the Museum of Comparative Zoölogy the following paratypes: another from Silva Lake, Saraca, Brazil, 172 mm. long, and:

No. 19,346	from Jutahy, Brazil	14 specimens	80–90 mm., young
19,366	Içá, Brazil	7 specimens	75 mm. and less, young
32,099	Lake Hyavary, Brazil	2 specimens	125 and 157 mm. coll. by L. Agassiz

A. borelli Boulenger, *A. orinocensis* Steindachner and *A. laticeps* Eigenmann, which also belong in the subgenus Schizodontopsis,— are not represented in the collections of the Museum of Comparative Zoölogy.

LAHILLIELLA Eigenmann and Kennedy

Anostomus nasutus (Kner)

Plate **3**, fig. 1

Schizodon nasutus Kner, Sitzb. Akad. Wien, **30**, 1858, p. 78, and Denkschr. Akad. Wien, **17**, p. 164, Taf. 6, fig. 14.
Anastomus nasutus Günther, Cat., **5**, 1864, p. 305.
Lahilliella nasutus Eigenmann and Kennedy, Smith. Inst. Misc. Coll., **45**, 1903–04, p. 144.

Dr. Eigenmann made this subgenus for Kner's species *Schizodon nasutus*, with the following subgeneric characters: "Teeth in lower jaw in a single series, multicuspid. Lateral line complete, faint. Dorsal over ventrals. Nares remote, snout broad, subelliptic in cross-section. Mouth directed obliquely downward and forward, lower jaw the shorter." "Type — *Schizodon nasutus* Kner; named for F. Lahille, of the Museo de la Plata."

Specific characters of *A. nasutus* (Kner): mouth subinferior, snout prominent, bluntish, extending beyond the mouth.

D. 11–12; A. 9–10; V. 10; L. l. 42–44; trans. 1.5–5½ — 4–4½; teeth 8/8, upper broad with 5 cusps.

Description.— Based principally on the original description by Kner of a specimen over one foot long from Irisanga.

Depth 5; head 6, with a thick, curved down snout and a mouth directed obliquely downward. Snout prominent, obtuse. Eye small, 5 in head, 2 in snout, 2 in interorbital space, which is convex. Teeth of intermaxillary (upper jaw) broad with five cusps on the cutting edge, those of the mandibular (lower jaw) shorter and bearing only three distinct cusps. Dorsal origin equidistant from end of snout and adipose fin. Caudal deeply notched, upper lobe pointed.

Scales have the appearance of low keels forming longitudinal streaks along the body.

Neither spots nor bands, except at the end of the caudal peduncle; a broad more or less indefinite spot of blackish brown on the ends of the medium caudal rays.

There were no specimens of this species among the fishes of the Thayer Expedition. Specimens described by Garman under this name in 1890 (Bull. Essex Inst. (**22**), p. 17) from Rio Puty are not *A. nasutus* Kner, but another new species described in more detail below.

One hitherto unidentified specimen in the Museum of Comparative Zoölogy collection, No. 26,577, collected in Rio San Francisco, Brazil,

and received from Prof. Harth (no date), is surely *A. nasutus* Kner. Here are its specifications: length, without caudal fin, 250 mm.; depth 68 mm., or 3.6 in body; head 55 mm., short, 4.5 in body; eye, 12 large, 4.5 in head. Interorbital space large, 2 in head, a little convex with a smaller portion in the region of nostrils. Lateral l. 41–42; transverse l. $\frac{5-5\frac{1}{2}}{5}$. Snout subobtuse and curved. Upper jaw the longer. Mouth subinferior. Lips very thick and fleshy, especially the upper one, which makes the snout protrude over the lower jaw. Lips cover the teeth when the mouth is closed. Teeth 8/8, upper with five cusps, lower with three cusps (on frontal teeth). The specimen is spotless and colorless, having probably been exposed to light.

D. 12; A. 9; V. 9. Dorsal high, its longest rays contained $1\frac{1}{3}$ in the body depth, equal to head. It is situated in front of ventrals. Pectoral short, reaching about half the distance to the ventrals. Ventrals and anal short; caudal forked, lobes well rounded. Scales striated, without leathery flaps on the end; they are sprinkled with some colorless spots or scratches, which are probably formed by the lack of the silver underlining in certain places. Back and belly rounded. Profile of the belly straight, while that of the back is curved.

The above characters do not quite correspond with the original description by Kner, the difference lying in the greater depth, position of mouth, and rounded lobes of the caudal. This specimen bears, however, all the other and most important characters of Kner's species, and the one particularly distinguishing it, the upper teeth with five cusps, which is not found in any other species of *Anostomus*. The form of the body is a minor difference which might be ascribed to the different localities where they were collected. Irisanga, (Matto Grosso), an affluent of the Madeira or Amazon and Rio San Francisco, are rather far apart.

Anostomus rostratus spec. nov.

Plate **4**, fig. 2

Anostomus nasutus Garman, Bull. Essex Inst., **22**, 1890, p. 23.

Specific characters.— Body high, depth 3, 6 in length — slender, sides and belly compressed; eye large, 4 in head; snout broad and thick, swollen near nostrils; mouth subinferior, directed forward; lips thin; teeth with only four cusps. Coloration dusky, with a spot at the root of caudal.

D. II, 10; A. II, 9; V. 9; L. l. 43–49; trans. l. 5/5; teeth 8/8, 4-cusped.

Description.— Type specimen, Museum of Comparative Zoölogy, No. 19,380a, 180 mm. long, from Rio Puty, Brazil, Thayer Expedition (there are 11 paratypes under No. 19,380). Body high and slender, back slightly rounded, sides and particularly the belly strongly compressed, which distinguishes this species from all other species of *Anostomus*. Profile of back slightly curved, while that of the belly all along convex.

Head short and broad, with snout subobtuse, thick and broad, somewhat swollen in the region of the nostrils, with broad mouth subinferior, directed forward, and supplied with thin lips, which do not cover teeth when the mouth is closed. Teeth eight on each jaw, with four cusps on frontal ones on both jaws.

Dorsal fin very high, its longest rays as long as head. Other fins short. Caudal with slightly rounded lobes. Scales large, sprinkled with spots, derived evidently from the silver underlining now partly gone.

Coloration dark brown, with a black spot at the root of the middle caudal rays.

The eleven paratypes are all alike and of about the same size.

There is one more specimen of this species in the Museum of Comparative Zoölogy collection, No. 20,458, collected by Allen and John, Thayer Expedition, in Januaria, South Brazil, in rather poor condition. Its measurements are: length 203, depth 50 (4 in body); head 48 (4.2 in body); eye 11 (4.3 in head). D II. 10; A. 9; V. 9. Scales along the lateral line gone; judging from what remains in other places, they are large. Teeth 8/8 on the upper jaw, with four cusps missing on the lower jaw. Body slender, sides and belly compressed as with the type. Mouth as with the type specimen. Coloration dusky, no visible spot at the root of caudal fin.

One peculiarity of this particular specimen is a short but pointed tubercle on the front of its head just on the boundary of the snout and head proper. It is probably an anomaly.

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EXPLANATION OF PLATES

Remarks.

1. The drawings for plates 1 and 2 were already prepared by Prof. L. Agassiz's artists and found by Dr. Thomas Barbour among the papers left by Garman.
2. Figures on plate 3 are reproduced from Kner's article "Zur Familie der Characinen," Denkschr. Akad. Wien, 1859, **17**, pls. 5 and 6.
3. Photographs for plate 4 were made by Mr. George Nelson of this museum from 65-year-old alcoholic specimens.

PLATE 1

PLATE 1

Anostomus trimaculatus Kner, from the specimen M. C. Z. No. 20.444, enlarged about $1\frac{1}{2}$.

Fig. 1. Lateral view.
Fig. 2. Ventral aspect.
Fig. 3. Snout, lateral view.
Fig. 4. Mouth open, front view.
Fig. 5. Snout with open mouth, lateral view.

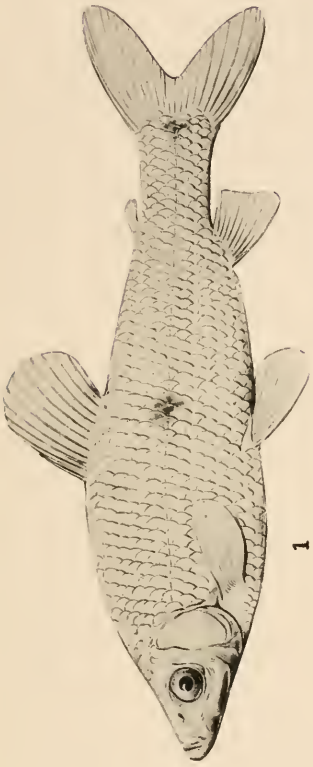

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PLATE 2

PLATE 2

Anostomus fasciatus Cuvier et Valenciennes, from the specimen M. C. Z. No. 20,462, enlarged about twice.

Fig. 1. Lateral view.
Fig. 2. Ventral aspect.
Fig. 3. Snout, lateral view.
Fig. 4. Mouth open, front view.
Fig. 5. Snout with open mouth, lateral view.

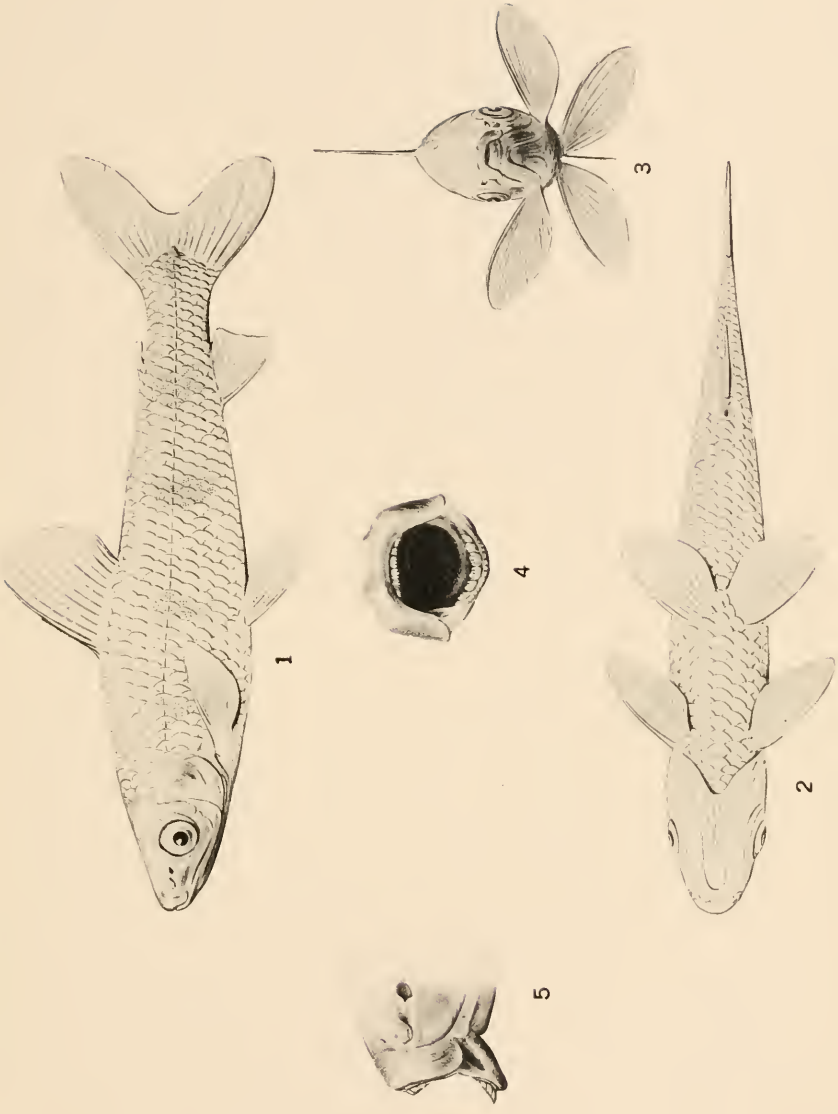
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PLATE 3

PLATE 3

Fig. 1. *Anostomus taeniatus* Kner, *a*. teeth; *b*. a scale from lateral line.
Fig. 2. *Anostomus nasutus* Kner, *a*. a tooth from the intermaxillary.

1

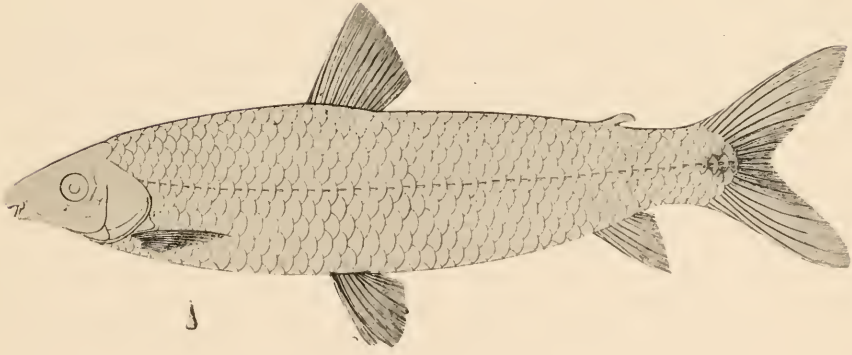

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PLATE 4

PLATE 4

Fig. 1. *Anostomus garmani*, new species, from M. C. Z. No. 19,380a, natural size.

Fig. 2. *Anostomus rostratus*, new species, from the specimen M. C. Z. No. 19,370, natural size.

1

2

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AT HARVARD COLLEGE.
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ATLANTIC DEEP-SEA FISHES

By N. A. Borodin

With Five Plates.

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM.
August, 1931

No. 3.— *Atlantic Deep-sea Fishes*

By N. A. Borodin

The Museum of Comparative Zoölogy received in 1928 a collection of Atlantic deep-sea fishes from Mr. Columbus O'D. Iselin, a graduate of Harvard College and a student in Oceanography under Dr. Henry B. Bigelow. Mr. Iselin, assisted by eight other young men, mostly graduate students, made in 1928 an exploring trip across the Atlantic between New York, the Azores and England, on the schooner "Atlantis." He succeeded in collecting and preserving in excellent condition many deep-sea fishes, some of them of comparatively large size.

This collection consists of 76 lots, among which are 32 species already known [1] and 6 which are new. Many rare specimens are represented of species established by Brauer and Zugmayer, which are probably not represented in any American museum, including for example *Macrostomias longibarbatus* Brauer, *Macropharynx longicaudatus* Brauer, *Aleposomus eyaneus* Zugmayer, *Bregmaceros macclelandi* Thompson, and *Tetragonurus cuvieri*. This latter is indeed an interesting fish with its cuirass of scute-like scales and tobacco-box-like mouth.

The six new species in the collection of 1928 were:

Avocettina scapularostris, p. 74, pl. 3, fig. 1–3.
Derichthys iselini, p. 75, pl. 3, fig. 4–6.
Lampanyctus peculiaris, p. 77.
Melamphaes bericoides, p. 79.
Pteraclis fasciatus, p. 84, pl. 4, fig. 2.
Aphareus obtusirostris, p. 85, pl. 5, fig. 2.

These have all been described in the Proc. New Eng. Zoöl. Soc., **10**, 1929, p. 109–11.

In 1929 another collection of deep-sea fishes was made by C. Iselin and R. McDonald during their cruise from Woods Hole, Massachusetts, to Bermuda. Although only five hauls were made they obtained 81 lots, which included 49 species already known.[2]

Many other rare fishes were collected on this short trip, as for example: *Ichthyoccus ovatus* (Cocco) known only from the Mediterranean, eastern Atlantic and Indian Ocean; *Nesiarchus nasutus* Johnson, known only from Portugal and Madeira (a specimen 880 mm. long); *Chaulio-*

[1] Thirteen bottles of *Myctophinae* and fifteen bottles of *Cyclothone* have been sent to Mr. A. E. Parr for study.

[2] Two bottles of *Myctophinae* and seven bottles of *Cyclothone* were sent to Mr. A. E. Parr for identification.

dus danae Regan and Trewavas; *Gavialiceps microps* Alcock; *Tilurella nemichthyidis infantis* Roule-Günther; *Photonectes margarita* Goode and Bean, and *Astronesthes niger* Richardson.

The six new species in the 1929 collection were:

Eustomias radicifilis, p. 65.
Aristostomias uncodentatus, p. 66.
Zaphotias nudum, p. 71, pl. 2, fig. 2.
Linophryne longibarbata, p. 83.
Haplophryne simus, p. 83, pl. 4, fig. 1.
Diaphus intermedius, p. 75.

These I described in Proc. New Eng. Zoöl. Soc., **11**, 1930, p. 87–92.

The deep-sea dredgings made on these two short voyages permit us to state once more that the mysterious depths of the ocean evidently remain still far from being fully explored. Nearly every haul discloses new forms.

The area within which these two collections were made is too small for basing a judgment on the geographical distribution of various deep-sea fishes, but the data obtained will be found useful, when combined with the records of other explorations. For this reason, we give below a list of the stations with their soundings, and the species of fish caught at each.

COLLECTION OF 1928

"Atlantis" Station No. 1. Lat. 39° 58′ N.; Long. 29° 46′ W., July 11.
Aphareus obtusirostris Borodin, probably collected from the surface

No. 4. Lat. 40° 49′ N.; Long. 30° 24′ W., July 14.
Argyropelecus hemigymnus Cocco
" *aculeatus* Cuvier et Valenciennes

No. 114. Lat. 41° 18′ N.; Long. 49° 22′ W., July 4, depth 800 fathoms (= 1,463 m.).
Myctophinae sp.
Cyclothone sp.
Chauliodus sloani Bloch and Schneider

No. 115. Lat. 41° 29′ N.; Long. 47° 48′ W., July 5, depth 700–800 fathoms (=1,280–1,463 m.).
Avocettina scapularostris Borodin
Myctophinae sp.
Cyclothone sp.

"Atlantis" Station No. 116. Lat. 41° 30′ N.; Long. 45° 57′ W., July 6, depth 700–800 fathoms (=1,280–1,463 m.).

Melamphaes bericoides Borodin
Myctophinae sp.
Cyclothone sp.
Melamphaes cocles (Vaillant)

No. 117. Lat. 41° 28′ N.; Long. 43° 29′ W., July 7, depth 700–800 fathoms (=1,280–1,463 m.).

Photostomias atrox Alcock
Macrostomias longibarbatus Brauer
Malacosteus niger Ayres
Chauliodus sloani Block and Schneider
Melanocetus krechi Brauer
Myctophinae sp.
Sternoptyx diaphana Hermann
Cyclothone sp.
Melamphaes nigrofulvus Garman
" *megalops* Lutken
" *mizolepis* Günther
Bregmaceros macclelandi Thompson
Pteraclis fasciatus Borodin

No. 118. Lat. 40° 56′ N.; Long. 39° 54′ W., July 8, depth 700–800 fathoms (=1,280–1,463 m.).

Aleposomus cyaneus Zugmayer
Nannobrachium nigrum Günther (=*Lampanyctus niger* (Günther)
Myctophinae sp.
Sternoptyx diaphana Hermann
Cyclothone sp.
Melamphaes mizolepis Günther
" *cocles* (Vaillant)

No. 119. Lat. 40° 05′ N.; Long. 35° 10′ W., July 9, depth 700–800 fathoms (=1,280–1,463 m.).

Myctophinae sp.
Caulolepis longidens Gill
Cyclothone sp.
Melamphaes mizolepis Günther
Tetragonurus cuvieri Risso

No. 141. Lat. 50° 40′ N.; Long. 27° 16′ W., August 28, depth 800–1,000 fathoms (=1,463–1,829 m.).

Nemichthys scolopaceus Richardson
Derichthys iselini Borodin

Eurypharynx pelicanoides Vaillant
Melamphaes cocles (Vaillant)
Myctophinae sp.

No. 143. Lat. 50° 00′ N.; Long. 35° 20′ W., September 2, depth 500 fathoms (–914 m.).
Stomias boa (Risso)
" *elongatus* Alcock
Chauliodus sloani Bloch and Schneider
Myctophinae sp.
Cyclothone sp.
Ceratias couesi (Gill)
Melamphaes unicornis Gilbert

No. 144. Lat. 47° 40′ N.; Long. 37° 20′ W., September 4, depth 600 fathoms (=1,097 m.).
Leptocephalus grassii Eigenmann and Kennedy
Stomias hexagonatus Garman
Chauliodus sloani Bloch and Schneider
Echiostoma barbatum Lowe
Lampanyctus peculiaris Borodin
Nannobrachium nigrum Günther
Myctophum metaclampum (Cocco)
" sp.
Cyclothone sp.
Melamphaes mizolepis Günther
" *unicornis* Gilbert

COLLECTION OF 1929

"Atlantis" Station No. 319. Lat. 34° 50′ N.; Long. 64° 20′ W., August 29, depth 1,500 m.
Myctophinae sp.
Chauliodus sloani Block and Schneider
Eurypharynx pelicanoides Vaillant
Lophodulus acanthognatus Regan
Melamphaes crassiceps Günther
Linophryne longibarbata Borodin
Haplophryne simus Borodin

No. 321. Lat. 33° 50′ N.; Long. 63° 55′ W., August 31, depth 1,500 m.
Myctophinae sp.
Cyclothone sp.
Sternoptyx diaphana Herman
Gonostoma elongatum Günther

Eustomias microcephalus Parr
Echiostoma barbatum Lowe
Malacosteus niger Ayres
Chauliodus sloani Bloch and Schneider
Macropharynx longicaudatus Brauer
Lampadena luminosa Garman
Diaphus dumerili Bleeker
Lampadena minima Tåning
Melamphaes nigrofulvus Garman
" *crassiceps* Günther
Lestidium sp.
Bathylagus atlanticus Günther
Bregmaceros atlanticus Goode and Bean
Dibranchus atlanticus Peters
Nemichthys infans Günther
Gavialiceps microps Alcock

No. 322. Lat. 33° N., Long. 64° W., August 31, depth 1,200 m.; net closed.
Myctophinae sp.
Gonostoma elongatum Günther
Argyropelecus hemigymnus Cocco
Sternoptyx diaphana Lowe
Diaphus elucens Brauer
" *hypolucens* Parr
Lampanyctus güntheri Goode and Bean
Lampadena luminosa Garman
Photostomias atrox Alcock
Zaphotias nudum Borodin
Aristostomias uncodentatus Borodin
Eustomias radicifilis Borodin
Nemichtys scolapaceus Richardson
Nemichthys sp.
Serrivomer sector Garman
Anoplogaster cornutus Cuvier and Valenciennes
Nesiarchus nasutus Johnson
Melamphaes bericoides Borodin

No. 323. Lat. 32° 50′ N.; Long. 64° 18′ W., September 2, depth 1,500 m.
Cyclothone sp.
Photonectes margarita Goode and Bean
Gonostoma elongatum Günther
Chauliodus sloani Bloch and Schneider
Malacosteus niger Ayres
Astronesthes niger Richardson

Chauliodus danae Regan and Trewavas
Lampadena luminosa Garman
" *minima* Tåning
Diaphus effulgens (Goode and Bean)
Odontostomus hyalinus Cocco
Caulolepis longidens Gill
Melamphaes crassiceps Günther
" *nigrofulvus* Garman
Serrivomer sector Garman
Gavialiceps microps Alcock
Zaphotias nudum Borodin
Ichthyococcus ovatus Cocco

"Atlantis" Station No. 325. Lat. 37° 00′ N.; Long. 67° 12′ W., September 4, depth 1,500 m. Net closed.
Cyclothone sp.
Sternoptyx diaphana Lowe
Chauliodus sloani Bloch and Schneider
Nesiarchus nasutus Johnson
Chauliodus danae Regan and Trewavas
Eurypharynx pelicanoides (Vaillant)
Lampadena luminosa Garman
" *bathyphila* Tåning
Lampanyctus güntheri Goode and Bean
Nemichthys infans Günther
Serrivomer sector Garman
Leptocephalus congri mystacis Grassi
Tilurella nemychtydis infantis Roule-Günther
Melamphaes crassiceps Günther
Linophryne longibarbata Borodin

Comparing these two collections of deep-sea fishes we note a considerable difference between the character of the fishes caught in 1298 and those taken in 1929. The more southerly cruise of 1929, in the direction of Bermuda, gave in general a more diversified ichthyological fauna than that of 1928 in the northern Atlantic, and more to the eastward.

In the collection of 1929 there are 49 species, while in the collection of 1928 only 32 species.

There are few (and only small-sized) representatives of the families *Melamphaidae, Sternoptychidae,* and but few of the genus *Myctophum* in the collection of 1929, while there are *much more* numerous representatives of the families of *Stomiatidae,* different genera of *Myctophidae,* although but few fishes of the genus *Myctophum.*

Several species were collected exclusively on the northeastern cruise, in the region of colder, less saline water; they are: *Avocetina scapularostris*, *Derichtys iselini*, *Tetragonurus cuvieri*, *Aleposomus cyaneus*, all species of the genus *Stomias* and *Macrostomias longibarbatus*.

Other species were found only on the southwestern cruise to Bermuda, namely: *Linophryne longicaudata*, *Haplophryne simus*, *Dibranchus atlanticus*, *Nesiarchus nasutus*, *Zaphotias nudum*, *Aristostomias uncodentatus*, *Anoplogaster cornutus*, *Odontostomus balbo*, *Scrivomer sector*, and *Tilurella* (larva of *Nemichtys*).

These two collections, though small, seem to indicate that two regions situated comparatively near each other, but differing in hydrological conditions, may have different fish communities.

The value of using a closing net is worth noting: at Stations No. 322 and 325, when the net was hauled closed, the catch was the richest in quantity and diversity of fishes caught, and the capture of a large specimen of a rare fish — *Nesiarchus nasutus* Johnson (about two feet long) was possible only because the net on this occasion was successfully closed.

ANNOTATED LIST OF THE ATLANTIC DEEP-SEA FISHES, COLLECTED BY C. ISELIN AND ASSOCIATES

ALEPOCEPHALIDAE

Aleposomus cyaneus Zugmayer

Plate 1

M. C. Z. No. 31,653, Station 118.

This rare fish, known only as a unique specimen briefly described by Zugmayer (Bull. Inst. Oceanogr., Monaco, 1914, No. 288, pp. 1–2), deserves a full description and illustration. Zugmayer wrote that the fish resembles *A. lividus* Brauer, but differs from it by having different dorsal and anal fins and smaller head. The only measurements given by this author are: D. 30; A.27; head 4.15; lateral line without scales, in which it differs from *A. squamilaterus* Alcock. Specimen was 150 mm. long and caught at Station 3,312, at 3,500 meters.

Our specimen is probably identical with Zugmayer's type, but we cannot be entirely sure, not having a description accompanied by a drawing. We, therefore, consider it necessary to redescribe the species.

Specific characters.— Head 4 in body; lateral line is perfectly visible

and consists of dash-like fine tubes and small pores, without any trace of scales, even rudimentary or subcutaneous.

D. 31; A.28; P. 7; V. 7.

Description of the specimen, Museum of Comparative Zoölogy No. 31,653, 175 mm. long, caught at Station No. 118 from a depth of 700–800 fathoms in the North Atlantic Ocean. Body much compressed and high, depth 5, scaleless, with well pronounced striae of muscles and lateral line; head high and large, 4 in body, its height $1\frac{1}{3}$ in the length. Snout short, blunt, $5\frac{1}{2}$ in head; eye large, round, 3 in head, with visible eyelid, slightly projecting over the head surface. Head and cheek have uneven surface; a cavernous snout has a slight prominence in front of the eyes. Maxillae reach the middle of the eye. Lower jaw with a short spine at its lower end. Minute villiform teeth on the borders of both jaws and in many rows on the palatine. Dorsal fin low and long, its origin a little in front of the vertical, passing through vent.

Anal similar to the dorsal, a little shorter.

Ventrals are inserted in the middle of the body; they are short, not reaching the vent. Pectorals short. Both ventrals and pectorals are about $\frac{1}{2}$ of body's height. Caudal deeply forked, its lobes have filamentous rays. At its base there are many rudimentary rays descending on the peduncle for about halfway to the anal and dorsal. Short filaments can be observed on the rays of all other fins. The skin is thin and covers the body loosely: the specimen has many large skin-plays on the back and belly. A great many round nodules are scattered all over the body and on the fins, and being of the same color as the skin — deep black — they are scarcely visible at first sight.

A large leathery flap is present on the margin of the opercle. Lateral line is perfectly visible; it is slightly produced, and consists of a line of alternate dash-like tubes and pores. No trace of any kind of scales could be found.

The naked body presents an elaborate pattern of muscle distribution on both sides of the lateral line; the muscular striae are well developed, and seem to be very characteristic.

Coloration of the body, deep black with a violet shading; head and fins dark brown.

Zugmayer considers *A. lividus* Brauer (Tiefsee Fische "Valdivia," taf. 2, fig. 1) as nearest to his type, but it differs in having shorter dorsal and anal fins. In the general form of the body and size of the dorsal and anal fins, *A. cyaneus* Zugmayer more nearly resembles *Xenodermichthys nodulosus* Günther and *X. squamilaterus* Alcock. Our specimen differs, however, from both in the absence of any scales

(rudimentary in *X. nodulosus*, or subcutaneous in *X. squamilaterus* Alcock), by a much larger head and eye, and longer maxillae. It differs also from *X. socialis* Vaillant, which has a much longer snout and no visible lateral line.

Two genera, *Aleposomus* and *Xenodermichthys*, resemble each other so closely that they are still confused by many authors. Brauer recognizes no difference between them, and gives the name *Aleposomus* for both (l.c., p. 20–21). Roule (Bull. Mus. Hist. Nat., **21**, 1915, pp. 42–46) made a short revision of these genera and found that they were distinct, the principal difference between them being in the number of rays in dorsal and anal fins, more than 25 in *Xenodermichthys* and less than 25 in *Aleposomus*. Jordan suggested the creation of a new genus *Rouleina* (Classification of Fishes, 1923, p. 122) not giving, however, any description of this new genus.

Recently McCulloch (1926, pp. 162–165), on the basis of the same fishes obtained by the Steamer "Endeavor," made another revision of these genera, and found that the proposed genus *Rouleina* of Jordan should be considered only a subgenus. He suggests that the two genera and one subgenus be distinguished principally on the basis of the size of the gill openings, which, according to him, do not extend above the pectorals in the case of *Xenodermichthys*, and which extend well above the pectorals in the subgenus *Aleposomus* and the subgenus *Rouleina*. The two subgenera differ in that the former has more than 25 rays and the latter 20 or less rays.

Our specimen, according to this new scheme, would belong to the subgenus *Aleposomus*. We must, however, state that there is still not sufficient material for making a final revision of these genera. Most of them were described on the basis of a single specimen, the only exception being *X. socialis* Vaillant which was caught in great quantities (more than a hundred).

BATHYLAGIDAE

Bathylagus atlanticus Günther

Cruise 1929, No. 61, Station 321.

Two small specimens 34 and 31 mm. long, without caudal, have the following characters: both depth and head 4 in body's length; eye enormous, $1\frac{3}{5}$ in head; snout 8 in head; interorbital space $2\frac{1}{2}$ in eye. D. 8, short, A. 12, long, but low, P. 7, almost as long as head, narrow and directed forwards ,V. 6, short, adipose on the vertical of the third

ray of the anal, situated near to the caudal. All vertical fins are set on a ridge of skin elevated over the level of the body. Small teeth in the small mouth, on the lower jaw only.

CHAULIODONTIDAE

Chauliodus sloani Bloch and Schneider

M. C. Z., No. 31,607, Station 117.

Three specimens, the largest 225 mm. long; No. 31,608, Station 143, six specimens, all but one nicely preserved. The stomach of one specimen, 137 mm. long, was entirely denuded and out of the body. The stomach contained: backbone of a deep-sea fish, 50 mm. long; a mass of half digested fish muscles; about a dozen spheres and hemispheres, which must be eyeballs and light-organs of deep-sea fishes. Specimens, Museum of Comparative Zoölogy, No. 31,609, Station 114 and No. 31,610, Station 144 are young, 57–60 mm. long.

Four more specimens were collected during the cruise 1929:

Station 319, original no. 4
Station 321, original no. 6
Station 323, original no. 5
Station 325, original no. 7

Chauliodus danae Regan and Trewavas

Cruise 1929, No. 54a, Station 323
Cruise 1929, No. 54, Station 325

STOMIATIDAE [1]

Stomias boa (Risso)

M. C. Z. No. 31,605, Station 143.

Stomias elongatus Alcock

M. C. Z. No. 31,604, Station 144.

[1] C. Tate Regan and Ethel Trewavas published recently a comprehensive work on the fishes of the families *Stomiatidae* and *Malacosteidae* ("Dana" Exped. Ocean. Rept. No. 6, issued March, 1930). According to the revision by these authors, a new family of *Malacosteidae* is formed, in which the genera *Photostomias* and *Aristostomias* are placed, besides the genus *Malocesteus*.

Many new species of *Eustomias* and *Aristostomias* are described in the paper, but none correspond with *Eustomias radicifilis* Borodin and *Aristostomias uncodentatus* Borodin, the descriptions of which were published January 30, 1930 (Proc. New Eng. Zoöl. Club, **11**, p. 89–90.

Stomias hexagonatus Garman

M. C. Z. No. 31,606, Station 144.

Three specimens, 100, 200 and 230 mm. long, nicely preserved, for even the iridescence of the skin remained.

Macrostomias longibarbatus Brauer

M. C. Z. No. 31,601, Station 117.

Two specimens, perfectly preserved.

Photostomias atrox (Alcock)

M. C. Z. No. 31,603, Station 117.

Cruise 1929, Station 322; original no. 26.

Echiostoma barbatum Lowe

M. C. Z. No. 31,602, Station 144.

Two specimens, 70–75 mm. long (probably young, as compared with specimen taken at Station No. 321, see below).

There is some difference between our specimens and the description and drawing of Goode and Bean (1896, p. 109, fig. 130). Ours have a differently shaped barbel, and much longer ventral fins, the filaments of which reach the anal. Günther's drawing of *E. barbatum* (1887, pl. 53, fig. 13) corresponds better than that of Goode and Bean, the only difference being that it does not show the characteristic filamentous end of the barbel; possibly it has been torn off.

One more character of this fish is worth mentioning: a well pronounced red spot under and behind the eye, which probably is a suborbital luminous organ.

The specimen caught in 1929, at Station 321, is 255 mm. long (adult) and does not differ from Goode and Beans' description and figure 130.

Eustomias radicifilis Borodin

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 89.
Type, M. C. Z. No. 32,268.

The most closely related species are *E. filiferum* Gilchrist and *E. enbarbatus* Welsh, but these have a shorter and differently shaped barbel, the structure of which more closely resembles *E. binghami* Parr (Parr, pp. 76–80).

Aristostomias uncodentatus Borodin

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 90.
Type, M. C. Z. No. 32,266.

This species differs from *A. grimaldii* Zugmayer (*A. titmanni* Welsh) in having a regular row of luminous side organs (not in groups), from *A. scintillans* Gilb in having a longer barbel, and from both of them in having fangs on both jaws and low, short fins.

Malacosteus niger Ayres

M. C. Z. No. 31,612, Station 117.

Two specimens, the larger 130 mm. long.

I would like to mention one thing about this peculiar deep-sea fish, unnoticed since Ayres' (1849, p. 53) description thereof. These fish always come out of the net almost dead, with mouth widely open. This is caused by the full extension of a rubber-like tendon, attached at its anterior end to the mandible between two fangs, and at the posterior end to the branchial arches, where it is divided into two branches. This tendon serves to bring the whole folding frame of the jaws back, after extending it for the purpose of opening the mouth and catching the prey.

Something similar is shown in fig. B, pl. 54 of Günther's Deep-sea Fishes, Challenger expedition, but the point of the posterior attachment is not correctly shown, and no word is said in the text about this most peculiar part of the mouth apparatus. In plate 3, fig. 2, Zugmayer (1911), this tendon is better shown, but the posterior end is directed too high. The function of the mechanism, however, is well explained by this author on the basis of Günther's description thereof for other Stomiatid fishes.

Five more specimens of this species were collected during the cruise of 1929 — two, each 80 mm. long, at Station 321, and three, 69, 85 and 110 mm. respectively, at Station 323.

Photonectes marginata (Goode and Bean)

Echiostoma marginata Goode and Bean, Ocean. Ichth., p. 109, fig. 131.

A large specimen (240 mm. long, without tail) of this rather rare fish was collected at Station No. 323, cruise 1929. Measurements and description of this specimen follow: depth, 55 mm. (measured at the posterior higher half of the body); head short, 52 mm. long and 35 mm.

high (very low). Lower jaw curved. Body fleshy, thick and rounded on back and belly. Only the anterior part of the body with the head, one-fifth of the total in all, and the posterior one-fifth, are compressed.

Dorsal and anal fins very high, covered with skin; ventral with very long filaments, two last ones the longest, reaching the ends of middle rays of the anal. Pectoral (only on one side, on the other torn off) — with one wire-like, rigid ray, 70 mm. long, originating a little above the row of luminous organs. Caudal short, only 15 mm. long. Barbel 23 mm. long, $2\frac{1}{2}$ in the length of the lower jaw, with six filaments and no bulb. Photophores on the body well defined; one row near middle of body's depth, and another on the belly.

The skin on the body thick, but often torn and ragged; a pectoral is gone, probably with the skin. Coloration dirty, dark gray. Stem of the barbel brown, its filaments white. Suborbital luminous organs rose-colored.

ASTRONESTHIDAE

Astronesthes niger Richardson

Astronesthes niger Richardson, Voy. "Sulphur," Ichthyology, p. 97, pl. 50, figs. 1–3.

Astronesthes myriaster Zugmayer, Bull. Inst. Ocean., Monaco, No. 253, 1913, p. 4.

Astronectes niger Regan, Dana Expedition. The Fishes of the family Astronesthidae and Chauliodidae, 1929, p. 20.

A single specimen of this rather rare fish was collected at Station No. 323, cruise 1929, 33 mm. long (without caudal). So far as known, there are only two specimens of this species in the American museums (labeled as *Chauliodus fieldii* Cuvier and Valenciennes), one of which is in the United States National Museum (Goode and Bean, 1896, p. 105), and the other in the Bingham Oceanographic Collection Yale University.

Zugmayer redescribed it as *A. myriaster*. His description is rather incomplete; he emphasizes particularly the most important character of this species, a great many small luminous spots on the skin, which suggested to him a very proper name "myriaster," i.e. thousand stars.

Regan, however, after comparing two of Zugmayer's type specimens in the Paris Museum with many specimens obtained by the recent "Dana Expedition," came to the conclusion that Zugmayer's type-specimens are *A. niger* Richardson. *A. myriaster* is, therefore, a synonym of *A. niger* Richardson.

Here are some measurements and details of our specimen. Depth 8 mm. (a slight difference from Richardson's type may be due to the immaturity of the specimen), 3.3 in length; eye 2 mm. (5 in head); snout 3 mm. (3.3 in head); D. 13, long and high, its origin behind ventrals; A. 6, short and low; P. 5, long, almost reaching ventrals; V. 4, long, reaching half way to the anal; caudal 5 mm. long. Mouth large, teeth on both jaws long, strong, not depressible. Two fangs on the lower and four on the upper jaw. Barbel 8 mm. long with an elongate whitish bulb. No conspicuous luminous organ on the head or body, but the skin on the belly and head is covered with small tubercles, which make it shagreened. Besides that, there are also numberless spots all over the body which are probably luminous. This is a very important character, which distinguishes *A. niger* and *A. indicus* from the other *Astronesthes*. This is strongly emphasized by Richardson and Zugmayer, but not mentioned in Regan's synopsis of the species.

STERNOPTYCHIDAE

Argyropelecus aculeatus Cuvier and Valenciennes

M. C. Z. No. 31,631, Station 322.

A well preserved specimen, 65 mm. long.

Argyropelecus hemigymnus Cocco

M. C. Z. No. 31,634, Station 322.

It is of some interest that both species of this genus were taken dead in 1928 at the same station, from the surface of the water, and that in no haul of that cruise were these species caught.

Sternoptyx diaphana Herman

M. C. Z. No. 31,632, Station 118.
M. C. Z. No. 31,632, Station 117.
Cruise 1929, Station 322.
Cruise 1929, Station 323.

MAUROLICIDAE

Ichthyococcus ovatus (Cocco)

Plate **2**, fig. 1

This rare fish has not yet been adequately described, evidently because of the few specimens examined. The drawings accompanying the descriptions made by Cocco, Bonaparte, Vaillant, Goode and Bean, and Brauer differ so much that I find it necessary to give here a full description and a drawing of the first specimen to be reported from the western Atlantic.

Specific characters.—Br. 11; D. 10; A. 12; P. 6; V. 8; C. 22; L. L. 32.

Description of the single specimen No. 32,292, taken at Station 323, 22 mm. long (without caudal).

Body short, deep, compressed, covered with scales, its depth $2\frac{3}{4}$ in length. Head high, narrowly compressed, 3 in body and about as high as long. Eye $3\frac{1}{2}$ in head, higher than broad. Interorbital very narrow. Snout short, obtuse, 3 in head. Mouth small. The lower end of the opercle descends far down and covers a portion of the lower jaw (see drawing). Margins of upper jaw finely denticulated. The anterior branchial arch extends forward to behind the symphysis of the lower jaw. Gillrakers short.

All the fins are supplied with slender, brittle rays. Dorsal high, its origin in the middle of body; anal low; pectoral as long as head; ventral only half so long; caudal forked; adipose fin fringed, very long, with conspicuous rudimentary rays of unequal length. There is a short fin, similar to adipose, between ventral and anal.

The scales of our specimen have been lost, but according to their impressions can be easily counted. Opercle and head naked.

Luminous organs numerous, of large size and arranged in regular rows (see drawing). There is one below the eye, one at the angle of the preopercle, two on the opercle, and eight between branchiostegals along the lower jaw and isthmus. On the belly the luminous organs are arranged in two rows: in the lower row there are 14 in the space between pectoral and ventral and 8 from ventral to anal; in the upper row 14 between pectoral and ventral and 10 between ventral and anal, 12 over the anal, and two leading to the caudal in a single row.

Body dusky; head colorless with the exception of some irregular star-like chromatophores on the cheeks.

There was some hesitation about the identification of this fish, be-

cause of the discrepancies in the description and drawings given by different authors. All authors, with the exception of Cocco, who discovered this fish, emphasized that it is scaleless and this character is the principal one for the *Maurolicidae* family, while our specimen shows so distinctly the traces of the missing scales that it cannot be admitted that it had no scales. Only after reading the original Italian description by Cocco, was I convinced that his Mediterranean specimens had scales.

The drawings made matters worse; no adipose fin is shown in the drawing by Cocco, Vaillant or Goode and Bean; a short one with only three rudimentary rays in second dorsal, i.e. adipose, is shown in the drawing in Bonaparte's paper, and the only adipose similar to that of our specimen is on the drawing accompanying the description of an Indian specimen of this fish by Brauer. The adipose fin with a long base and the presence of a short pre-anal adipose must be recognized as the most marked specific character of this rare fish.

This fish, according to Cocco, is rare even in its native sea, the Mediterranean. It was found by the "Talisman" expedition in the eastern Atlantic, not far from the Mediterranean, and later in the Indian Ocean by the "Valdivia" expedition. It was unknown in the western Atlantic, and, therefore, its recent discovery near the American coast is of particular interest.

After a careful comparison of the measurements and characters of our western Atlantic specimen with the descriptions heretofore given, I am convinced that there is no reason to propose a new specific name.

Here are the principal characters of the specimens from different seas:

	Medit. (Cocco)	East. Atl. (Vaillant, after drawing)	Indian (Brauer)	West. Atl. (mihi)
Depth	3	$3\frac{1}{4}$	2.8	$2\frac{3}{4}$
Head	3	$3\frac{1}{4}$	3–3.4	3
Eye	—	3	3	3
D.	13	11	11–12	10
Adip.	3 rudimentary	none	numerous rays	fin rudimentary
P.	8	—	8	6
V.	6	—	7	8
A.	16	12	14–15	12
L. l.	—	36	38	32

A few words more about the characters of the *Maurolicidae*. The name was proposed by Jordan and Evermann for the group *Coccina* of the *Sternoptychidae* Günther (Cat. Brit. Fish., **5**, 1864, p. 384). An

important character was the structure of the branchial system, which has been included in the family's characters, namely, the anterior branchial arch extending forward to behind the symphysis of the lower jaw. The body has been called "scaleless," but the *Sternoptyehidae* include species both with scales and without. *Ichthyococcus* is surely nearer to *Maurolicus* than to *Sternoptyx* and its allies, but its body is covered with scales so that, it seems, it would be proper to regard the *Maurolicidae* as "scaleless or covered with scales," as was previously given in the description of the *Sternoptichidae*.

Zaphotias nudum Borodin

Plate 2, fig. 2

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 88.
Type, M. C. Z. No. 32,291, seven paratypes.

The size and form of the anal presents the best character for recognizing fishes belonging to the genus *Bonapartia* (Goode and Bean, 1896 = *Zaphotias* Jordan and Evermann, 1898).

The photophores are very numerous, and some of them are placed in somewhat unusual places, as for example on the branchiostegal membrane, where there is one photophore for each of the twelve branchiostegals. They are very conspicuous, and are seen from the outside through the transparent bones as a very regular row of short vertical bars, but examined from the inside, they show the usual structure of photophores and are comparatively large in size. They are mentioned by Goode and Bean (1896, pp. 102–103) in their description of the only two known specimens of their new genus and species called *Bonapartia pedaliota* as a "series of vertical elongated spots, apparently phosphorescent, on either side of the lower jaw, giving it a pectinate appearance," and they are shown in figure 120 accompanying their description. There is no doubt that in the species *B. pedaliota*, the photophores are also situated on the branchiostegal membrane, as with our species.

Besides these twelve photophores there is a regular row of small, single photophores on the ventral portion of the body, closely set one to the other; 14 between the pectoral and ventral and 5 between the ventral and anal; 13 large, double photophores on the supra-anal area and 6 of the same kind between anal and caudal; the two last are set close to each other, but without ascending to the upper base of the peduncle. There is one photophore at the angle of the preopercle, but none on head or sides of body.

Coloration of specimens in alcohol absent, with the exception of a slightly darkened back, nape of head and base of caudal, and of phosphorescent opercle. No dark traces of scales.

The monotypic genus *Bonapartia* was introduced in 1896 by Goode and Bean (p. 102). The only known specimens up to the present, two, 1 to 2 inches (26–52 mm.) long, were taken by the "Albatross" at Station 2,642 in 25° 20′ 30″ N. Lat., 70° 58′ W. Long., at a depth of 217 fathoms (about 434 metres), in the Gulf Stream. The name *Bonapartia* being preoccupied, Jordan and Evermann (1898, p. 580 and p. 2,826) changed it to *Zaphotias*, and the only known species of which the two type specimens are in the United States National Museum, No. 44,337, is *Zaphotias pedaliotum* (Goode and Bean).

Our new species is the second one of this genus. It has all the most important generic characters, such as general disposition of photophores, very similar radial formula and a peculiar form of long-rayed falcate anal fin. But there are several characters, not included in the generic diagnosis, as given by Goode and Bean, namely, the absence of scales, absence of photophores on the caudal peduncle above the single row along the whole ventral line of the body, teeth of two sizes on the jaws, and forked caudal.

The discovery of another new species, undoubtedly belonging to this genus, suggests the introduction of the following additional characters to the generic diagnosis given by Goode and Bean.

Body scaleless or covered by scales; photophores on the branchiostegal membranes and in a single row along the whole ventral line of the body to the base of the caudal; photophores on the peduncle present or absent. Caudal forked; teeth on both jaws of equal or unequal size.

The new species differs from the *Z. pedaliotum* (Goode and Bean) in having teeth of unequal size and the absence of scales and photophores on the peduncle. There are more photophores, 38–39 being counted on 8 specimens (not including 12 on the branchiostegals), while in *Z. pedaliotus* they number only 35. The photophores above and behind the anal fin are conspicuously larger in size, double, and not so closely set as those of the anterior portion of the body, which appear as small dots. In this respect our species again differs from *Z. pedaliotus*.

The caudal fin was missing or so badly damaged in the specimens of Goode and Bean that they questioned whether it was "*subtruncate*," accompanying this word with "probably" in parenthesis (l.c., p. 102). This can positively be changed to "*forked*," because our specimens all have very well defined furcation.

ANGUILLIDAE

Leptocephalus grassii Eigenmann and Kennedy

M. C. Z. No. 31,672, Station 144.
Cruise 1929, Station 325.

These are larvae of the American eel, *Anguilla chrysypa* Rafinesque.

NEMICHTHYIDAE

Nemichthys infans Günther

Cruise 1929, Station 321.
Cruise 1929, Station 325.

Tilurella nemichtydis infantis Roule and Günther

Cruise 1929, Station 325.

This is the larva of *N. infans*.

Nemichtys scolopaceus Richardson

M. C. Z. No. 31,669, Station 141.
Cruise 1929, Station 322.

A well preserved specimen.

Nemichthys sp.

One of the nemichtyoid fishes of the collection, unfortunately badly damaged in the pectoral portion, differs from others in having a considerable sac under the lower jaw, partly recalling a large sac of the fishes belonging to the family *Saccopharyngidae*, but differently situated and small in size. This sac is formed by a branchiostegal apparatus, its membrane being extended in the form of a sac, on the sides of which seven branchiostegal bones are easily visible (see pl. 5, fig. 3).

This strange sac together with some other differences from known species of *Nemichthys* induce me to make a full description of the fish, as a possible new species, but I do not characterize it formally, because of the mutilation of the specimen.

Description of a single specimen, No. 32,299, 173 mm. long, collected at Station No. 325, cruise 1929. The worm-shaped body, somewhat

twisted by the preservative, probably tapering to the filamentous tail, is scaleless, and its greatest depth (measured in the region of the head) is more than 80 times in its length and 15 times its head. Head, measured from the tip of the beak to the ends of branchiostegals, forming the skeleton supporting the said sac, is $5\frac{1}{8}$ in body's length. Eye small, 30 times in head, situated over the junction of the jaws. Snout $2\frac{1}{2}$ in head; the beak has the typical form of Nemichtyoid fishes with the upper jaw (the longer) bent upwards. The sac is as long as the snout and half as deep (it probably has shrunk in alcohol).

Both jaws have numerous, well developed teeth, different in shape from *N. infans* Günther. The only fin which could be found, the anal, is long and has hairy rays, twice as long as the depth of the body, evidently with large interspaces between them. The origin of this fin is at a point $\frac{1}{3}$ way above the body's length. It does not reach the tip of the tail, which is without any rays.

It must be remarked that the skin in the region of pectoral and ventral fins is entirely torn off. Twisted body and damaged skin on the back make it impossible to say anything about the dorsal fin.

Coloration dark brown all over, with the exception of the tail, which is white.

Gavialiceps microps Alcock

Cruise 1929, Station 321.
Cruise 1929, Station 323.

Serrivomer sector Garman

Cruise 1929, Station 322.
Cruise 1929, Station 325.

Avocettina scapularostris Borodin

Plate **3**, fig. 1–3

Proc. New Eng. Zoöl. Club, **10**, 1929, p. 109.
Type, M. C. Z. No. 31,671.

Coloration yellowish white; upper part of the head, tip of the snout and of the tail dusky, and dotted with small round pores.

Our species differs very distinctly from the three other known species of the genus *Avocettina*, established by Jordan and Davis, namely, *Avocettina* (*Nemichthys*) *infans* (Günther) — generic type; *A. elongata* Jordan and Evermann and *A.* (*Labichthys*) *bowersi* (Garman), in having an entirely different snout, shorter body and filamentous tail, as well as by several other characters.

DERICHTHYIDAE

Derichthys iselini Borodin

Plate 3, fig. 4–6

Proc. New Eng. Zoöl. Club, **10**, 1929, p. 110.
Type M. C. Z. No. 31,670.

Coloration gray-yellow, with dusky subcutaneous dots; belly ruddy brown.

This species differs from the type species *Derichthys serpentinus* Gill by the form and position of the nostrils, by a very conspicuous lateral line and by a differently shaped dorsal fin. It is worth mentioning that the peculiar form of the nostrils of our fish does not correspond to the family or the generic characters given by Gill, on the basis of a single specimen (U. S. N. M. No. 33,523). According to him: "nostrils lateral; in front of the eye; neither tubular" (Goode and Bean, 1896, p. 161). But with this exception, our new species which, without any doubt, belongs to this group of rare long-necked deep-sea eels, has the characters of the family and the genus. It was named for Mr. C. Iselin, who collected these fishes.

SACCOPHARINGIDAE

Eurypharynx pelecanoides (Vaillant)

(Syn. Macropharynx longicaudatus Brauer)

M. C. Z. No. 31,613, Station 141.
M. C. Z. No. 31,614, Station 141. Very well preserved specimen.
Cruise 1929, Station 319.
Cruise 1929, Station 325.

MYCTOPHIDAE

Diaphus intermedius Borodin

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 89.
Type M. C. Z. No. 32,289, and one paratype.

The most nearly related species is *D. coeruleus* Klunzinger, which has a different form of the upper antorbital organ (vertically oval and not triangular); differing radial formula, different number of photophores and scales in the lateral line.

It must be remarked that *D. coeruleus* is known only from the Indian Ocean.

Diaphus metaclampus (Cocco)

M. C. Z. No. 31,615, Station 144.

Diaphus dumerili Bleeker

Cruise 1929, Station 321.

Diaphus elucens Brauer

Cruise 1929, Station 323.

This specimen differs slightly from Brauer's type in having 18 rays in dorsal fin instead of 14, and the eye 3 times in head instead of 3.5. In this respect and in the number of supra-anal photophores, it approaches *D. fragilis* Tåning, which unfortunately is not yet fully described.

Here are some characters of our specimen: length 66 mm.; depth 14 mm.; head 18 mm.; D. 18; A. 16.

Diaphus effulgens (Goode and Bean)

Cruise 1929, Station 323.

Lampanyctus niger (Günther) = Nannobrachium nigrum Günther

M. C. Z. No. 31,629, Station 118.
M. C. Z. No. 31,630, Station 144.

There was at first some doubt as to the proper identification of our specimens, whether *N. nigrum* (Günther) or *N. macdonaldi* Goode and Bean. Measurements were made and parallel data concerning the two known species have been compiled and the result presented in the following table:

Nannobrachium (= Lampanyctus)

	M. C. Z. No. 31,629	*N. nigrum* Günther (Challenger Deep-sea Fishes, p. 199, pl. 60, fig. 13)	*N. macdonaldi* Goode and Bean (Ocean. Ichthyology, p. 94, fig. 110)
Depth	7	5½	5
Head	4½	3⅔	3½
Eye	6	5	5
Snout	5	5	—
Scales in L. L.	35	34	35
D.	15	14	13
A.	T. 20	19	16–17
P.	6	3–4	3
V.	7–8	—	—
Color	Brown-black	Black	Purplish brown
Size	2½ inches	4½ inches	5 inches

As a result of this comparison it is possible to conclude that all three specimens belong to one and the same species, and, by priority, they then must be called *N. nigrum* Günther. Our specimen differs from Günther's type more than from *M. macdonaldi*, namely by the depth and head's height, but having in view that our specimen may be a young one, the said differences may be ascribed to its age.

Lampanyctus peculiaris Borodin

Proc. New Eng. Zoöl. Club, **10**, 1929, p. 111.
Type, M. C. Z. No. 31,628.

None of the species included in the works on deep-sea lantern fishes — Goode and Bean, Garman, Brauer, Zugmayer, Tåning, Parr — correspond to our species, because their adipose fins are not rayed.

The nearest species is *L. caudispinosus* (Johnson), but its dorsal fin has 26 rays, its pectoral is short, and its adipose fin is of ordinary structure.

Lampanyctus güntheri Goode and Bean

Cruise 1929, Station 322.
Cruise 1929, Station 325.

Caudal fin with black bars beautifully arranged. Eyes a bright shining blue.

Lampadena luminosa Garman

Cruise 1929, Station 321.
Cruise 1929, Station 325.
Cruise 1929, Station 322.

Lampadena minima Tåning

Cruise 1929, Station 321.
Cruise 1929, Station 323.

GONOSTOMIDAE

Gonostoma elongatum Günther

Cruise 1929, Station 321, 6 specimens.
Cruise 1929, Station 322.
Cruise 1929, Station 323.

ODONTOSTOMATIDAE (=SCOPELARCHIDAE)

Odontostomus balbo Risso, new subspecies atlanticus

Cruise 1929, Station 323.

A single specimen of this interesting fish, No. 32,280, 77 mm. long (without caudal) presents the following characters: depth 6; head 4.3 in the body's length. Eye $3\frac{3}{5}$ in head, telescopic, looking upwards. D. 12; A. 34; P. 12. Caudal forked, 7.7 in body's length. Long fangs on the palate and on the lower jaw. They are depressible, a character which is not emphasized enough in the synopsis of Goode and Bean (l.c., p. 121) and Parr (l.c., p. 163).

This species has been known only from the Mediterranean. The only difference between Risso's type and our new subspecies (according to the description given by Goode and Bean and the figure given by Günther, 1887, plate 52, fig. A) consists in coloration: the Mediterranean species is colorless, while ours is grayish with well marked iridescence on cheeks and peduncle.

PARALEPIDIDAE

Lestidium sp.

Specific characters.— Body scaleless, short; depth $7\frac{1}{2}$; head very long, 3 in length; eye large, 4 in head; snout very long, 2 in head.

D. 6; A. 24; P. 10.

Description of a single specimen 27 mm. long, collected at Station 321, cruise 1929. Body short, scaleless, with a long head and short tail. Snout long, half of the head's length. Eye large, $\frac{1}{4}$ of the whole head. The long jaws are supplied with well developed teeth, unequal in size and sparsely set. No trace of scales, even hidden under the skin, along the lateral line or elsewhere.

Dorsal and anal originate on the same vertical. Pectoral rather long. All fins are filamentous with hairlike rays. Adipose small. Caudal forked.

Coloration.— Small stars of dusky pigment, sparsely set all over the body which causes a light grayish color. The anterior portion of the belly is dark because of blackish intestines, but the surface of the skin in this particular portion is metallic bronze with a kind of phosphorescence. There are some scattered phosphorescent spots on some other portions of the body.

Compared with two other species of Lestidium — *L. elegans* Parr (Bull. of the Bingham Ocean. Coll., **3**, 1928, Art. 3, pp. 44–76) and *G. atlanticum* Borodin (Bull. Vanderbilt Ocean. Mus., **1**, 1929, Art. 1, p. 10) — our specimen shows the following differences: its body is much shorter, the head and snout are longer, and the eyes are larger.

This specimen is probably immature, but may represent a new species.

GEMPHYLIDAE

Nesiarchus nasutus Johnson

Cruise 1929, Station 325. Specimen 790 mm. long (standard).
Cruise 1929, Station 322. Specimen 280 mm. long (standard).

This is a rather rare fish in the eastern portion of the Atlantic, known only from the region of Madeira and the deep waters off Portugal. On the smaller specimens a crustacean parasite was found attached in the skin and muscles, just above the gill opening.

BREGMACERATIDAE

Bregmaceros macclelandi Thompson

M. C. Z. No. 31,668, Station 117.

I was inclined at first to identify this fish as *B. atlanticus* Goode and Bean (1896, fig. 331), but a closer examination has shown that it is nearer to *B. macclelandi* Thompson, because it has two separate dorsal fins, with hardly visible short single rays between them, while *B. atlanticus* is described and figured as having one continuous dorsal with a lower median portion thereof. *B. macclelandi* Thompson has two separate dorsals like our specimen. (See Charlesworth's Mag. N. H., **4**, 1840, p. 184 and Day, Fishes of British India, 1878–1888, **2**, p. 418, fig. 151).

Two more specimens of this fish were caught at Station 321, cruise 1929.

MELAMPHAIDAE

Melamphaes bericoides (Borodin)

Proc. New Eng. Zoöl. Club, **10**, 1929, p. 110.
Type, M. C. Z. No. 31,627.

This fish combines characters of both Bericoid and Scopelid fishes. The structure of its cavernous head, with small mouth and short cleft, shows it belongs to the genus *Melamphaes*, but the general form of the

body, shape of scales, form of fins, recalls a Myctophid fish, from which it differs, however, by the structure of the upper jaw, which is not formed by the premaxillary bone.

Another specimen of this new fish, 160 mm. long, was collected at Station 322, cruise 1929.

Melamphaes mizolepis Günther

M. C. Z. No. 31,656, Station 117.

Large specimen, 108 mm. long (Günther's type was 76 mm.), with some scales still on the body and many others fallen off but preserved with the specimen. The scales (in spirits) are of milk-white color, their size 20 x 20 mm.; only sixteen scales along the lateral line. They resemble the luminous scales of some myctophids, and it is quite possible that they are phosphorescent. Their form and structure differs entirely from the scales of common fishes.

There are many more large specimens of the same species in the collection:

M. C. Z. No. 31,654, Station 118.
M. C. Z. No. 31,655, Station 119.
M. C. Z. No. 31,657, Station 144.

Melamphaes unicornis Gilbert

M. C. Z. No. 31,663, Station 144.
M. C. Z. No. 31,664, Station 143.

Melamphaes beanii Günther

(Syn. Scopelogadus cocles Vaillant)

M. C. Z. No. 31,660, Station 141.
M. C. Z. No. 31,661, Station 116.
M. C. Z. No. 31,662, Station 118.

Melamphaes megalops Lutken

M. C. Z. No. 31,658, Station 143.
M. C. Z. No. 31,659, Station 117.

Melamphaes nigrofulvus Garman

M. C. Z. No. 31,665, Station 117.
Cruise 1929, Station 323.

A large specimen, 80 mm. long.

Cruise 1929, Station 321.

Melamphaes crassiceps Günther

Cruise 1929, Station 319. 2 specimens.
Cruise 1929, Station 321. 6 specimens.
Cruise 1929, Station 323. 6 specimens.
Cruise 1929, Station 325. 10 specimens.

Caulolepis longidens Gill

M. C. Z. No. 31,666, Station 119.
Cruise 1929, Station 323.

Anoplogaster cornutus (Cuvier and Valenciennes)

Cruise 1929, Station 322. 1 specimen 35 mm. long.

TETRAGONURIDAE

Tetragonurus cuvieri Risso

M. C. Z. No. 31,667, Station 119.

This is a very rare and in many respects a peculiar fish, and it deserves special notice.

It was first discovered in the Mediterranean, and described by the Italian ichthyologist Risso in 1810. Later Cuvier and Valenciennes gave a full description of this strange fish in their capital work Histoire Naturelle des Poissons (**11**, 1836, pp. 176–186, fig. 318). Still later a specimen was collected in the eastern Atlantic and was described by Lowe, Fishes of Madeira, 1843–60, pp. 129–131, pl. 19, as *T. atlanticus*, but because it differed very little from Risso's, Goode and Bean considered it to be the same species (l.c., p. 230). The only specimen of this rare fish, reported previously from the Atlantic coast of North America, was taken near Woods Hole, Massachusetts (United States National Museum No. 44,436). Our specimen is, therefore, only the second from the western Atlantic.

It is only 54 mm. (a little more than 2 inches) long, and evidently young, as Risso's specimen was 13 inches, and Lowe's $9\frac{1}{4}$ inches long. Though the measurements of the head (near 4 in length, and of the eye, $3\frac{1}{3}$ in head) are nearer Lowe's description than to that of Risso-Cuvier, we are inclined to agree with Goode and Bean, that both are the same species.

The striking peculiarities of this fish as stated by Risso, then by Valenciennes, and later by Lowe, are:

1. Structure of mouth and particularly of lower jaw. Lowe writes on this subject: "When the mouth is opened the lower jaw presents a most remarkable appearance, from the extraordinary elevation of its sides, resembling enormously high gums, and shutting into or within the upper jaw, like the high raised sides of a box, or the arched end of a trunk with a round top within its lid. . . . The greatest height thereof exceeds half the length of the jaw. . . . Lower jaw resembles the hollow square stern of a ship or boat with steep high sides. . . . Frontal notch is very deep. Teeth in a single row. . . ." (p. 135).

2. About another peculiarity, the scales, he writes: "The whole body, the opercles, and the cheeks are covered with a peculiar kind of hard and compact armour of large close-set scales, elegantly and beautifully disposed, like neatly plaited braids of hair, in regular oblique subspiral rings, or arcuated lines, descending obliquely forwards from the dorsal to the ventral edges. There are 83 lines. On the caudal they are more keeled, scales are rhomboid longitudinally striate with the edge finely pectinociliate. Striae are composed of rows of distant imbricated spines or teeth. The surface is rough when the finger is drawn from the tail forwards, and silk smooth when the hand is drawn in a contrary direction" (p. 137).

3. Risso stated, and confirmed it by his own dangerous experience, that the flesh of this fish is a violent poison.

All authors agree that this fish usually inhabits great depths, and that it appears along shore or in the surface only occasionally. This is the reason why it has rarely been found. Cuvier and Valenciennes placed it among the mugiloids. Lowe considered it as belonging to the *Scombridae*, but Goode and Bean, Günther, and Boulenger rate it, and no doubt rightly, as a monotypic genus of a new family *Tetragonuridae*, which is placed between the *Sphyraenidae* and the *Stromateidae*. Jordan and Evermann also include in this family the genus *Chenodax* Maclay. But it must be admitted that, because of its rarity, nobody has studied the anatomical details of the structure of this species in order to find out its phylogenetic position. It is, therefore, much to be hoped that future deep-sea explorers may secure a sufficient number of this rare fish for anatomical research.

CERATIIDAE Regan [1]

Ceratias couesi (Gill)

M. C. Z. No. 31,650, Station 143, 85 mm. long.
M. C. Z. No. 31,651, Station 143, 43 mm. long.

The large specimen is somewhat damaged, the skin torn off and viscera exposed. Remnants of fish and crustaceans were found in the stomach. The eyes are hardly visible, and appear as transparent spots on the skin without any real sight organs beneath. The small specimen is in perfect condition.

LINOPHRYNIDAE Regan

Linophryne Collet

Linophryne longibarbata Borodin

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 87.
Type, M. C. Z. No. 32,307.

This new species combines the characters of two others which are closely related, *L. lucifer* Collet and *L. coronata* Parr, having the general form of the body, belly, head, mouth and teeth similar to the first named, with the illicium and appendages of *L. coronata* Parr. But it differs from both of them in having a far longer barbel.

Another specimen of the same new species, only 35 mm. long (standard) was collected at Station No. 319. Its total length, together with caudal, 48 mm.; its barbel measure 71 mm. (twice the length of the body without tail).

ACERATIIDAE

Haplophryne Regan, 1912

Haplophryne simus Borodin

(Plate **4**, fig. 1)

Occ. Papers Boston Soc. Nat. Hist., **5**, 1930, p. 285.
Type, M. C. Z. No. 32,308, p. 285

It is difficult to find a proper place for this new fish in the revised system of the ceratoid fishes proposed by Regan. In the form of the

[1] Regan in his revision of Ceratoid fishes, 1926 (see Bibliography), formed ten families out of the old family Ceratidae. I follow his classification in this paper.

body and other very important characters, it must be referred to the nearest genus *Haplophryne;* but the presence of an illicitum and a translucent skin are the most important characters of this genus, while our fish has no illicitum (at least it could not be discovered without dissection or some manipulation liable to mutilate the unique specimen), and its skin is pigmented and not transparent.

In general form of the body it is nearest to *Aceratias mollis* Brauer (p. 324–325, pl. 16, fig. 10), which Regan included in his new genus *Haplophryne*, but our species has a differently shaped head with pug-shaped muzzle, different structure of nostrils, and a projecting lower jaw.

Mr. W. Beebe in a recent paper described the new species *Haplophryne hudsonicus* (Zoologica, **12**, No. 2, 1929). Our specimen has much in common with this new species, but differs from it in having a differently shaped snout and lower jaw, eyes oval (not round), skin dully pigmented (not transparent) and some other minor characters.

Parr (1930, see Bibliography), on the basis of an osteological study, gives a tentative key to the genera of allied pediculate fishes of the family *Aceratidae*. Applying the characters of his classification, our specimen can be included in the genus *Haplophryne* Regan, 1912, and no 1916 and 1926.

MELANOCETIDAE

Melanocetus krechi Brauer

(Syn. Melanocetus johnsoni Günther)

M. C. Z. No. 31,652, 20 mm. long, Station 117.

MALTHIDAE

Dibranchus atlanticus Peters

Cruise 1929, two young specimens (30 mm. with tail), Station 321.

PTERACLIDAE

Pteraclis fasciatus Borodin

(Plate **4**, fig. 2)

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 91.
Type, M. C. Z. No. 32,120 and one smaller paratype.

This new species of *Pteraclis* differs from the four other known species, *P. papillo* Lowe from Madeira, *P. ocellatus* Cuvier and Valen-

ciennes from Canal of Mozambique, *P. carolinus* Cuvier and Valenciennes from the coast of California, and *P. velifer* (Pallas) from the Indian Ocean (Günther, Cat. Fish. Brit. Mus., **2**, pp. 410–411) by having a much shorter and higher body, well pronounced black vertical bands along the sides, absence of spines on the opercle and preopercle, cycloid scales without any spines, and a different radial formula.

APHAREIDAE

Aphareus obtusirostris Borodin

(Plate **5**, fig. 2)

Proc. New Eng. Zoöl. Club, **11**, 1930, p. 91.
Type M. C. Z. No. 32,199 and one paratype.

From the other known species of *Aphareus*, *A. furcatus* (Lacepéde) *A. fulvivultus* (Jenkins) and *A. rutilans* (Cuvier and Valenciennes),[1] the present one differs in having a strange looking, abruptly cut snout,

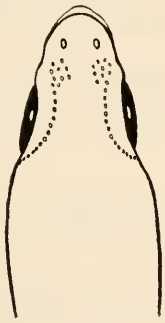

Fig. 1. — Head of Aphareus obtusirostris.

slightly curved in its general outline, and a peculiar decoration made of pores on the top of the head. The genus *Aphareus* was formerly included in the families *Lutianidae* and *Haemulidae*. In Jordan's Classification of Fishes a separate family *Apharcidae* was introduced.

This fish does not belong to the deep-sea fauna and was evidently taken at the surface. We include it in this paper because it was taken during the same cruise as the abyssal species.

[1] Jordan, Evermann and Tanaka. Notes on new or rare fishes from Hawaii. Proc. Cal. Acad. Sci. (4 ser.), **16**, 1927, p. 670.

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EXPLANATION OF PLATES

PLATE 1

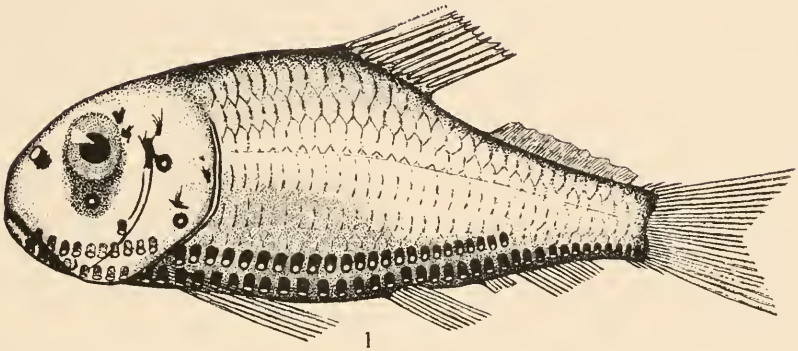
PLATE 1

Aloposomus cyaneus Zugmayer

PLATE 2

PLATE 2

Fig. 1. *Ichthyococcus ovatus* (Cocco).
2. *Zaphotias nudum* new sp.



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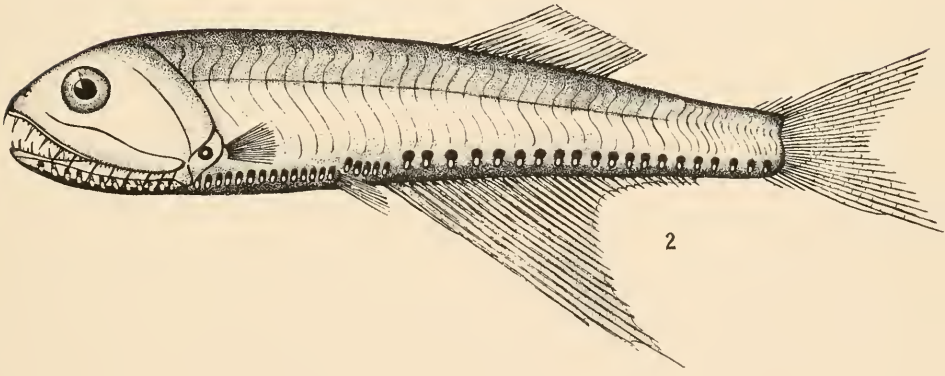

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PLATE 3

PLATE 3

Fig. 1. *Avocettina scapularostris* new sp. Fig. A. The whole fish, $\frac{2}{3}$ of the natural size. Fig. B and C. Head four times enlarged, top and back view.

Fig. 2. *Derichtys iselini* new sp. Fig. A. The whole fish, $\frac{2}{3}$ of the natural size. Fig. B and C. Head enlarged four and half times, top and back view.

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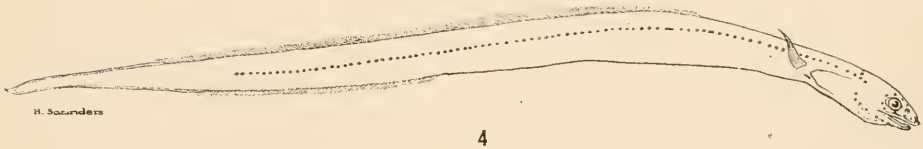

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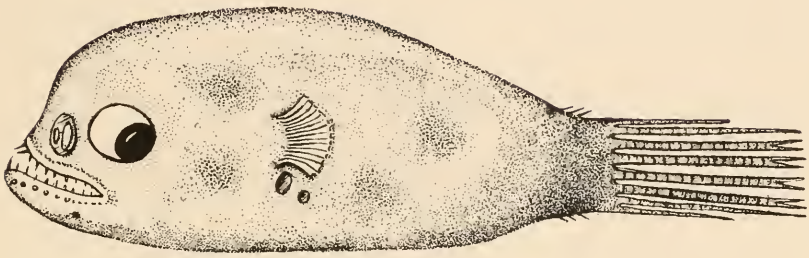
PLATE 4

PLATE 4

Fig. 1. *Haplophryne simus* new sp.
2. *Pteraclis fasciatus* new sp.



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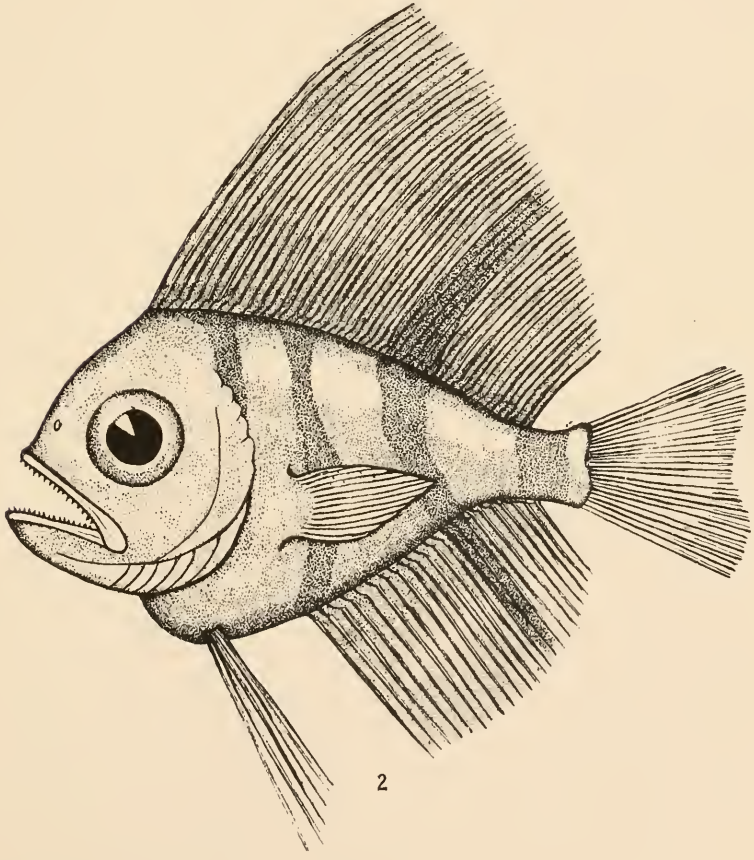

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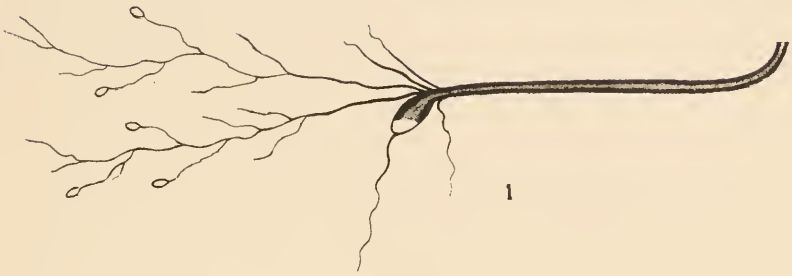
PLATE 5

PLATE 5

Fig. 1. Barbel of *Eustomias radicifilis* new sp.
2. *Aphareus obtusirostris* new sp.
3. Head of *Nemichtys* sp.



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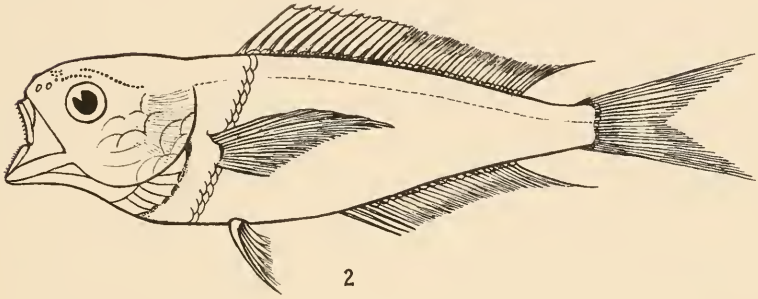

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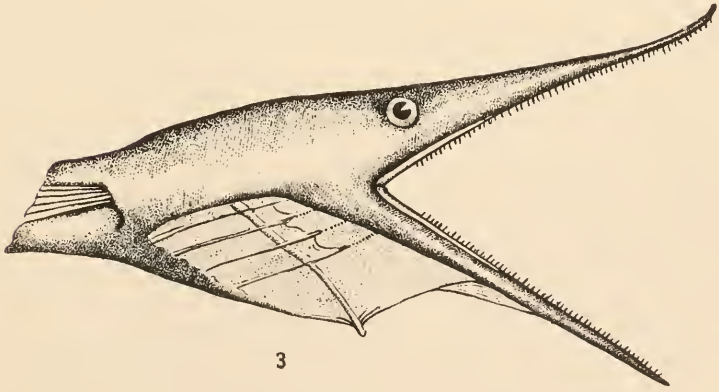

3

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE

VOL. LXXII, No. 4

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC, IN CHARGE OF ALEXANDER AGASSIZ, ON THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

XXIII

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XXXVII

STOMATOPODA OF THE SOUTHERN AND EASTERN PACIFIC OCEAN AND THE HAWAIIAN ISLANDS

BY ROBERT PAYNE BIGELOW

WITH TWO PLATES.

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SEPTEMBER, 1931

No. 4.— *Stomatopoda of the Southern and Eastern Pacific Ocean and the Hawaiian Islands*

By Robert Payne Bigelow

Introduction

The Stomatopoda comprise a peculiar and well defined order of Crustacea that inhabit the littoral waters of the seas, chiefly in tropical regions. This report deals with collections made by the United States Fish Commission Steamer "Albatross" under the direction of Alexander Agassiz and on other expeditions during the years from 1901 to 1905. The studies were carried on during summer vacations of a very busy life, and suffered many interruptions by other duties and responsibilities, both official and personal. The various sections of this report having been written at different times, some inconsistencies may be expected. Facilities for these studies were afforded by the Biological Laboratories of the Massachusetts Institute of Technology, the United States Fisheries Biological Station, Woods Hole, Mass., the Marine Biological Laboratory of Woods Hole, and especial thanks are due to Dr. W. T. Calman and to Dr. L. A. Borradaile for their hospitality and the permission to examine collections in the British Museum (Nat. Hist.) and the University Museum, Cambridge, England.

With the permission of Mr. Agassiz, the adult forms have been treated separately from the larval forms in the plankton, which have not been studied. The adult forms represent five genera and seventeen species and varieties, of which one species is new. Late postlarval stages of three species of Pseudosquilla also are described; one of these, the postlarval stage of *P. ornata*, is described for the first time.

The publication of Kemp's very excellent monograph (1913), based on the extensive collection in the Indian Museum, caused a change from the plan originally contemplated for this report, and greatly simplified the problem. Wherever possible, I have followed him in classification, and I have used the same anatomical terms (1913, p. 12–13).

Under each species, any fact of general biological interest that has come to my attention has been noted. Variability is marked in some species, as *Gonodactylus chiragra*, *G. oerstedii*, *G. glabrous*, *Pseudosquilla ciliata*, and *Squilla oratoria*. *Odontodactylus japonicus* and *Pseudosquilla ciliata* exhibit sexual differences in color, but no structural

secondary sexual characters. On the other hand, *Gonodactylus chiragra*, *G. glabrous*, and *Lysiosquilla maculata* show marked sexual differences in structures not directly connected with reproduction. *Gonodactylus guerinii* seems to be a very interesting case of mimicry.

A few species are used for human food, notably *Lysiosquilla maculata*, *Squilla oratoria*, and *Pseudosquilla ciliata*.

GONODACTYLUS Latreille

Gonodactylus Latreille, Encycl. Méth., 1825, **10**, p. 473.
Gonodactylus H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, p. 528 (*partim*).
Gonodactylus De Haan, in Siebold's Fauna Japonica, Crust., 1849, p. 220.
Gonodactylus Miers, Ann. Mus. Nat. Hist., 1880, (5), **5**, p. 115 (*partim*).
Gonodactylus Brooks, Voy. H. M. S. "Challenger" Stomatopoda, 1886, **16**, p. 55.
Protosquilla Brooks, ibid., 1886, p. 65.
Gonodactylus Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 492.
Protosquilla Bigelow, *ibid.*, 1894, p. 492.
Gonodactylus Hansen, Isop., Cumac., und Stomatop. d. Plankton-Exped., 1895, p. 86.
Gonodactylus Nobili, Ann. Sci., Nat. Zoöl., (9), 1906, **4**, p. 328.
Gonodactylus Kemp, Mem. Ind. Mus., 1913, **4**, p. 145.

Type Species.—*Gonodactylus chiragra* (J. C. Fabricius, 1781).

Diagnosis.— Stomatopoda with a compact, generally convex and compressed hind body, without dorsal carinae on the first four abdominal segments. Carapace little, if at all narrowed anteriorly, without carinae; gastric grooves distinct, cervical groove entirely absent. Ischio-meral articulation of raptorial claw situated at a point in advance of the proximal end of merus, upper margin of propodus smooth or finely serrate, dactylus inflated at the base and without teeth on the inner margin. Shorter ramus of last three thoracic appendages linear and composed of two segments. Telson variable. Ventral process of uropods terminating in two sharp spines, of which the inner is usually the shorter.

History of the Genus.— The genus *Gonodactylus*, as recognized by Latreille (1825) and subsequent authors, included the Stomatopoda with compact, rounded hind body, without carinae, except on the last two abdominal segments, and with peculiar raptorial limbs, in which the dactylus is dilated at the base and the propodus is without pectination on the inner margin.

In this group Brooks (1886) found three distinct assemblages of species, which he regarded as of generic rank: *Gonodactylus s.s.*, of

which *G. chiragra* is the type; and two others which he named *Protosquilla* and *Coronida*, respectively. The genus *Protosquilla* was made to include all those species in which the sixth abdominal somite is immovably fused with the telson. This Brooks regarded as a primitive character from its resemblance to the condition found in certain larval stages.

In the genus *Coronida* he included *Squilla bradyi* of A. Milne-Edwards (1869) and *Gonodactylus trachurus* of Miers (1884). These species agree in having small antennary scales and uropods, teeth on the inner margin of the raptorial dactylus, and the hind body depressed.

The discovery by the present writer of a species from the Gulf of Mexico, possessing all the characteristics of *Gonodactylus* with the addition of teeth on the raptorial dactylus, led to a fresh examination of the literature and the separation from *Gonodactylus* of another genus under the name *Odontodactylus* Bigelow (1894), of which *Cancer scyllarus* of Linnaeus is the type.

At the time when Brooks set apart the genus *Protosquilla*, the ontogeny of the species in that group was entirely unknown. In 1895 Hansen described a postlarval stage of *Protosquilla folinii* in which the telson is completely movable on the sixth abdominal segment. Whereas in the adult the fusion is so complete that even the suture between the two somites has disappeared. I may add that this is true of the dorsal side only. An examination of specimens in the British Museum (Natural History), which I was permitted to make by the kindness of Dr. W. T. Calman, shows in this and most other species of *Protosquilla* a distinct groove, if not a suture, separating the two somites on the *ventral* side. From these facts it is evident that Hansen is right in concluding that the chief characteristic of *Protosquilla* is not primitive, as supposed by Brooks, but is a secondary adaptation. He states further that in *Protosquilla trispinosa* White (*pulchella* Miers) the telson is mobile on the sixth abdominal segment, about half as much so as in *G. oerstedii*. Hansen therefore has reunited the Protosquilla group with the genus Gonodactylus. In this he is followed by Nobili (1906), Giesbrecht (1910), and Kemp (1913).

Kemp divides Gonodactylus into four groups of species:

Group I includes *G. chiragra*, *demani*, *graphurus*, and their immediate allies. In these species the anterior angles of the carapace are advanced and rounded. The rostrum has a median spine and rounded, subacute, or rarely acute lateral angles. The mandibular palp has three distinct segments. The uropods are normal.

Group II is composed of six highly specialized and peculiar species;

G. herdmani, *drepanophorus*, *brevisquamatus*, *fimbriatus*, *spinosocarinatus*, and *furcicaudatus*. The anterior margins of the carapace are as above. The rostrum is trispinous. The uropods are peculiar — the proximal segments of the exopodite extends far beyond the articulation of the distal segment, and the movable spines on its outer edge are usually recurved; the endopodite is usually crescentic.

Group III is nearly equivalent to the genus Protosquilla of Brooks, including *G. trispinosus*, *stoliurus*, *excavatus*, *folini*, *brooksi*, *spinosissimus*, and the like. In these species the anterior margins of the carapace do not slope forward. The rostrum is typically trispinous. The mandibular palp consists of two segments. The posterior margin of the sixth abdominal somite is distinctly incurved in the middle. The uropods are normal.

Group IV contains a single species, *G. acanthurus*, in which the antero-lateral angles of the carapace are advanced and the rostrum is trispinous. The mandibular palp is absent. Both the endopodite and the terminal segment of the exopodite of the uropods have setae on only the distal half of their outer margins; the inner margin in each case bears sharp spines.

Considerable differences of opinion have been expressed in regard to the relationships of the species in Group I. For this reason it may be well to give a résumé of the history of the group. At the time of the Challenger Expedition two species had been described. These were *G. chiragra* Fabricius (1781) and *G. graphurus* Miers (1875). In the Challenger collection there was a single female specimen which differed from *G. graphurus* chiefly in the absence of markings on the first five abdominal somites. This was described by Brooks (1886) as *G. glabrous*.

In 1893 Pocock described a small form under the name *G. smithii* which differs from *G. chiragra* in the narrowness of the carinae and strength of the spines on the sixth abdominal somite and telson. In the same year two other species were described. They are very much alike and differ considerably from *G. chiragra* in the form of the carinae on the telson, which is covered by minute spines. These species are *G. demani* Henderson (1893) and *G. spinosus* Bigelow (1893).

In 1895 the definition of *G. chiragra* was made more precise by Hansen, who distinguished, under the name *G. oerstedii*, the Atlantic form with accessory carinae on the intermediate marginal teeth of the telson, entirely absent in the typical Indo-Pacific form. This difference was mentioned and figured by Borradaile (1898), and later was confirmed by the comparison of a large number of specimens, and again figured by the present writer (Bigelow, 1910). There was published

also in 1895 a series of drawings by the late James Wood-Mason. On Plate III of this work figures 3 to 9 are of *G. platysoma*, male and female, clearly showing the sexual differences in this form, which is much more robust than typical *G. chiragra* and entirely lacks lateral marginal teeth on the telson.

A few years later several varieties of *G. chiragra* were described by de Man (1898 and 1902) and by Barradaile (1900). These include var. *acutirostris* de Man (1898), which later was given full specific rank by Borradaile (1907) and by Kemp (1913). Among the varieties of *G. chiragra*, Borradaile included *G. smithii* Pocock and, doubtfully, *G. oerstedii* Hansen.

In 1903 Lanchester published an elaborate and thoughtful treatment of the varieties of *G. chiragra*, and under this name he included all of Kemp's Group I and added a number of named varieties. He classified the varieties under three headings. The first two of these form a bifurcated "transitional scheme," or phylogenetic tree. The starting point of this scheme is var. *tumidus*, "in which there are three much swollen carinae, without spines, on the telson, and no lateral marginal teeth."

From this both lines of variation are in the direction of an increase in the number of central carinae. They lead through forms having an "anchor" on the median carina to forms having five well developed carinae grouped in the centre of the telson. The first line of variation starting from var. *tumidus* leads through intermediate forms to var. *acutus*, var. *smithii*, and var. *glabrous* "*term a*," ending finally in var. *graphurus*, *with* spines on the three central carinae. The second heading, or line of variation, begins with var. *incipiens* and ends with var. *glabrous* "*term b*," having very swollen carinae *without* spines. By "term" Lanchester means one of the limits of individual variation within a variety. It will be noticed that the two "terms" of var. *glabrous* lie in distinct lines of variation (evolution?), although, as he states, they are connected by numerous intermediate forms. Under the third heading, Lanchester places var. *anancyrus* Borradaile, var. *acutirostris* de Man, *G. spinosus* Bigelow, and other species of Group I, which he regards as varieties of *G. chiragra*, not falling into his transitional scheme of variation.

In his criticism of Lanchester's paper, Kemp (1913), while recognizing the importance of this work, says that a "careful survey of the large collection in the Indian Museum seems to show he failed to lay sufficient emphasis on the more outstanding features of the case." I entirely agree with Kemp, and would add that Lanchester's scheme

seems to me to be an entirely artificial one, based on the study of insufficient material. The development of the sculpturing of the telson and other characteristics of many Stomatopoda depends on three factors: age, sex, and size-limit. All animals tend to approach a certain size as a limit and the maximum size often differs greatly in closely related species and varieties. When these factors are neglected, confusion in classification is sure to follow. Lanchester's varieties *tumidus* and *acutus* furnish a case in point. Through the kindness of L. A. Borradaile, M.A., Sc.D., Fellow of Selwyn College, I was permitted to examine the type specimens in the Cambridge University Museum, and I am convinced that they are merely well developed males and females respectively of *G. platysoma* Wood-Mason. The intermediate forms are probably immature males or very old females.

Lanchester is not followed by many subsequent writers. Jurich (1904) places *G. smithii* Pocock and *G. acutirostris* de Man with the synonyms of *G. chiragra*, without discussing the variations. Lenz (1905) gives *G. chiragra* (Fabr.) including Borradaile's var. A and var. B, *G. chiragra*, var. *smithii* Pocock, and regards as distinct species *G. spinosus* Bigelow and *G. graphurus* Miers. Tattersall (1906) recognizes *G. chiragra* var. *smithii* Pocock, *G. chiragra* var. *incipiens* Lanchester, and *G. glabrous* Brooks.

In his paper on Stomatopoda from the Western Indian Ocean, Borradaile (1907) gives valuable keys to the species of Gonodactylus, to the varieties of *G. chiragra*, and to the varieties of *G. glabrous*. Under *G. chiragra* he recognizes the following varieties:

Var. A, *incipiens* Lanchester 1903 (type)
Var. B, *anancyrus* Borradaile 1900
Var. D, *smithii* Pocock 1893
Var. F, *tumidus* Lanchester 1903
Var. G, *acutus* Lanchester 1903 (*segregatus* Lanchester, 1903)
Var. H, *affinis* de Man 1902
Var. K, *confinis* de Man 1902

Var. A. was designated as the typical form without varietal name in his previous paper. In this he differs from Lanchester who took var. *tumidus* for the type. Varieties C (*acutirostris*) and E. (*oerstedii*) of his previous paper are recognized in this one as distinct species.

Kemp (1913) has made good use of the large collection of Stomatopoda in the Indian Museum by taking it as the basis for a complete revision of the group. Reference to his treatment of the genus *Gonodactylus* has been made in a previous paragraph. He paid especial

attention to the variations of *G. chiragra* and gives the results of the examination of 230 specimens. Of these, six were strikingly different from the rest and included the type specimens of *G. platysoma* Wood-Mason. While not regarding this form as of specific rank, he finds intermediate forms so rare that it constitutes a distinct variety, worthy of a name.

The case is quite different with the other 224 specimens. In these he finds a perfectly continuous series of variations. Of these he gives a table showing the locality, size, sex, and varietal form of each specimen, following Borradaile's key and adding numerous intermediate forms. These represent a grouping of individual variations within the species *G. chiragra ss.*, and are not worthy of varietal names, which are rejected in favor of the letters previously used also by Borradaile and by Lanchester.

This whole investigation is of the greatest assistance in a correct classification of these animals, and some of the general results deserve special mention in this place. Kemp observes that there is greater variation among small specimens than among large ones. To explain this condition, he offers three alternative hypotheses: I, specimens exhibiting extreme variations die young; II, there are dwarf races; III, peculiar young animals tend to become more normal at subsequent moults. Kemp is inclined to accept the third hypothesis, and regards the second one as highly improbable. With this I disagree. Great variations in maximum size are found frequently among the species of a genus and among varieties and races within a species. There is no reason why this should not occur in *G. chiragra*, and in fact, the collection at present in my hand seems to afford direct evidence of the existence of dwarf races.

Kemp observes that there is no trace of correlation between sex and varietal form, and his table (1913, p. 159) seems to substantiate this view. But it does not agree with my experience. It is certainly not true of var. *platysoma*. In a previous paper (Bigelow, 1894) I described three species of *Squilla* in which the full grown males differ from the females in having the margins and carinae of the telson thickened to a marked degree. A similar condition obtains in var. *platysoma*. In males over 62.5 mm. long the central carinae of the telson are more or less tumid and are noticeably different from those in the females, which are narrow. Smaller males are like the females. Examination of Lanchester's type specimens in the Cambridge University Museum has convinced me that his var. F–*tumidus* and var. G–*acutus* are identical with var. *platysoma* (Wood-Mason). All of the types of var. *tumidus*

are males, all of var. *acutus* are females, and the intermediate forms (Lanchester, 1903, p. 447) are three females and one small male. I have noticed the same condition in typical *G. chiragra* and in smaller races that may merit classification as distinct varieties. Especially impressive are the cases where two or more specimens are gathered in the same locality. Frequently I have been able to predict the sex of such specimens by comparison of their telsons and have verified the predictions by examination of the genital orifices.

Of Lanchester's varieties of *G. chiragra* as defined by Borradaile 1907, varieties A and B, with carinae of telson rounded or broad, appear to represent the typical male forms of *G. chiragra ss.* (Kemp); while variety D, with these carinae compressed, represents the extreme female form of telson, in the same way that varieties F and G represent the typical male and female characteristics, respectively, of *G. chiragra* var. *platysoma* (Kemp).

The impression that I obtain from the study of a considerable number of specimens, those in the English museums, as well as the present collection, and a longer series from the Philippines (report in course of preparation), is that the shape of the carinae of the telson changes with age, being narrow and compressed in the young and becoming more or less swollen or tumid with increase in size; and this change appears earlier and progresses farther in males than it does in females. To this extent the sculpturing of the telson presents secondary sexual characters.

Group I, Kemp, 1913, p. 145

Diagnosis.— Species of *Gonodactylus* in which the anterior margin of carapace slopes forward on either side of the rostrum with the antero-lateral angles well in advance of the rostral base; rostrum with sharp median spine and antero-lateral angles rounded or subacute, rarely acute; mandibular palp with three distinct segments; posterior margin of sixth abdominal somite straight or slightly curved in dorsal view; proximal segment of the exopodite of the uropod projects distally a little beyond the articulation of the ultimate segment, and its external margin is armed with a series of straight, or almost straight, movable spines; endopodite of uropod normal in shape, and, as a rule, in the disposition of its setae.

Type Species.— *Gonodactylus chiragra* (Fabricius).

Species Represented in the Collection.— *Gonodactylus chiragra* (Fabricius); *G. chiragra* var. *platysoma* (Wood-Mason); *Gonodactylus oerstedii* var. *festae* (Nobili); *Gonodactylus glabrous* Brooks.

Gonodactylus chiragra (Fabricius)

Squilla chiragra Fabricius, Species Insectorum, 1781, **1**, p. 515.
Gonodactylus chiragra, Latreille, Encycl. Méth., 1825, **10**, p. 473, pl. 325, fig. 2.
Gonodactylus chiragra Kemp, Mem. Indian Mus., 1813, **4**, pp. 155–162, text fig. 2, pl. 9, fig. 107 (*ubi syn.*).
Gonodactylus chiragra var. *smithii* Rathbun, Proc. Zoöl. Soc., 1914, (2), p. 664.
Gonodactylus chiragra Bouvier, Bull. Sci. France et Belg. (7), 1915, **48**, p. 312.
Gonodactylus chiragra Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 179–181.
Gonodactylus chiragra Alexander, Jour. Proc. Roy. Soc. W. Australia, 1916, **1**, pp. 8–10.
Gonodactylus chiragra Stebbing, Ann. Durban Mus., 1917, **2**, p. 28.
Gonodactylus chiragra Sunier, Inst. Sci. Buitenzorg, Contr. Faune des Indes Néerl., 1918, **1**, fasc. 4, p. 74.
Gonodactylus chiragra Tattersall, Jour. Linn. Soc., Zoöl., 1921, **34**, p. 354.
Gonodactylus chiragra Balss, Kungl. Svenska Vet. Akad. Handl., 1921, **61**, no. 10, p. 5.
Gonodactylus chiragra Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111, fig. 6.
Gonodactylus chiragra Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, p. 8.
Gonodactylus chiragra Edmondson, B. P. Bishop Mus. Bull. 1925, No. 27, p. 60.
Gonodactylus chiragra Hansen, Siboga-Exped. Monogr., 1926, **35**, (Livr. 104), pp. 24–29.
Gonodactylus chiragra Komai, Mem. College of Sci., Kyoto Imp. Univ. (B), 1927, **3**, (3) p. 338.

Diagnosis.— A Gonodactylus of Group I, in which the carapace is slightly narrowed in front and its greatest breadth is about three quarters its median length; rostrum with stout median spine, which may extend beyond the middle of the eye stalks, and antero-lateral angles subacute or broadly rounded; eye stalks about one fourth the median length of the carapace, cornea very oblique; mandibular palp with three segments; propodus of raptorial limb greatly dilated at distal end and armed with a single mobile spine; dactylus strongly inflated at base, and with the distal end flexed inward; abdomen strongly arched and smooth, except for lateral marginal carinae, which do not end in spines. Greatest breadth of fifth abdominal somite less than one fifth the total length of the animal; sixth abdominal somite with six longitudinal carinae of variable thickness, with or without terminal spines; telson broader than long, with two small tubercles near the anterior margin close to the intermediate carinae of the sixth abdominal somite. In the centre of the dorsal surface are three smooth longitudinal carinae of variable width, but always separated by a definite interspace. The median one, or crest, may have a terminal spine and usually has small lateral outgrowths at the posterior end, giving it the form of an anchor. The flukes may be separate and may be provided with spines. Sub-

median and intermediate marginal teeth well developed and each provided with a single carina. Lateral margin sharply carinate with a sharp notch representing the lateral tooth, which is never well developed. Basal prolongation of the uropod broad and ending in two strong spines, of which the outer one is the longer and reaches the end of the exopodite. The inner margin of the outer spine is unarmed.

General Description.— Of this species Kemp (1913) has given a long and accurate description which is summarized in the diagnosis given above and need not be repeated here. In a later paper Kemp (1915) gives the results of a study with comparative measurements of a long series from the Philippine Islands, and he concludes that of all varieties that have been recognized by distinct names, only one, var. *platysoma* W.-M., can be maintained. I agree with Kemp in regarding var. *platysoma* Wood-Mason as a distinct variety or subspecies, and in considering as merely individual variations of *G. chiragra s.s.* all of the varieties listed by Borradaile (1907), with two exceptions. The exceptions are var. F and var. G (varieties *tumidus* and *acutus*, Lanchester, 1903), which I have found to be identical with var. *platysoma*. In making this decision concerning the variations of *G. chiragra*, I am relying in part on my own observations on the collections of the U. S. Philippine Expedition, to be described in a subsequent paper, and on other specimens in various museums, in addition to the present collection. See above pp. 109 to 112.

The Samoan investigations of 1902 yielded only six specimens that can, with certainty, be classified as *G. chiragra s.s.* Of these, five are from Apia, and the other from Pago Pago. The largest is a female 68.5 mm. long (S.8).[1] It is of the typical form (var. A). The carinae of the sixth abdominal segment are well rounded and constricted posteriorly into small spines. The carinae of the telson are moderately rounded. The crest is distinctly convex in lateral view; it has a well developed anchor and no spine. The lateral angles of the rostrum are produced forward and are rather broadly rounded at the ends. S.9*c* is a male 32 mm. long from the coral reefs at Apia. It closely resembles S.8, except that the carinae of the sixth abdominal segment are narrower and their spines stronger, and the "anchor" on the telson is less marked. A larger male, S.10*a* (51 mm.), from Pago Pago differs from these two by having the carinae of the telson much more swollen (var. AF?). The lateral angles of the rostrum are strongly produced and subacute. Three specimens from the coral reefs at Apia (S.9*a*, *b*, and *c*) have identical markings (Pl. 2, Fig. 1). The small male has been described above. The other two are a male (*a*) 45.5 mm. long and a female (*b*) 37 mm. long. The

[1] Each specimen in the collection is given a serial number for convenience of record.

rostrum of the male has subacute lateral angles, and the carinae of the sixth abdominal segment and of the telson are very much swollen. The central one, or crest, is very tumid without spine, and the flukes of the anchor are indistinct (var. AF?). The female has a rostrum like the smaller male (*c*), and its posterior somites differ greatly from the condition found in both males. The carinae are very narrow and on the sixth abdominal somite they are produced without constriction into stout spines. The crest of the telson is very narrow and is produced at the posterior end with a short blunt spine. The flukes of the anchor are distinct and narrow (var. D). There can be no doubt of secondary sexual differences in these specimens. The larger male is very different from the female, and the smaller male is intermediate between the two in respect to the secondary sexual characters, while all three are identical in every other respect and appear to have been collected at the same station. Another female, 40 mm. long from Apia, S.11, is exactly similar to S.9*b*, except for a slight difference in color.

In the collection from Pago Pago, there are two very small specimens (S.10*b* and *c*) that differ so much from the typical *G. chiragra* as perhaps to merit classification in a distinct variety. The lateral angles of the rostrum are not produced at all. The anterior margin on each side of the median spine slopes backward and meets the diverging lateral margin at a rounded right angle. The basal prolongation of the uropods is very well developed and its outer spine extends beyond the distal end of the exopodite. The submedian and intermediate marginal teeth of the telson are well developed, and the lateral tooth is very distinct. In the female (19 mm.) the carinae of the sixth abdominal segment are rather broad and end in strong spines. The crest of the telson is rounded, broader in its anterior half, and ends posteriorly in a stout spine. The anchor flukes are well developed. The other carinae of the telson are strongly developed and narrow. The male shows the sexual differences usually characteristic of larger specimens. The carinae of both the sixth abdominal somite and the telson, except the marginal ones, are very much swollen. The crest of the telson is very broad and convex, and has a small spine at the posterior end. The anchor is indistinct. The length of the eye stalks in both specimens is equal to more than half the median length of the carapace. This seems to be a juvenal character, as also is, perhaps, the form of the rostrum. But the precocious development of sexual differences seems to indicate a dwarf race, similar to one found in the Philippine collection. The present specimens, however, entirely lack accessory carinae, which are characteristic of the Philippine form.

Color.— Kemp (1913, p. 160) notes the variability of the coloring of

this species in the fresh or living condition, the general tone being in some cases yellow, in others dull orange, brick red, or olivaceous brown. He finds also a sexual difference in coloring. The males are, in most cases, very darkly colored on the ventral surface, while the females are invariably pale beneath.

Stebbing (1917) quotes from Mr. Bell Morley the description of a specimen (sex not given) from Durban, South Africa. The color is violet black, with dark red about the tail; legs and antennae orange; and raptorial claws bright violet about the folding place.

Distribution.— All the specimens of *G. chiragra s.s.* in the present collection were taken in Samoa, five of them at Apia. In one case "coral reefs" is given as the station, and probably all were taken during shore collecting. One characteristic female (S.10*a*) and the two small specimens described above were taken at Pago Pago. According to Kemp (1913), this species has been found over a wide area, extending from Point Natal, Africa to the Red Sea and Gulf of Suez. From there it extends eastward to Japan, Komai (1927). This species was taken at forty nine stations of the Siboga Expedition in the vicinity of the Dutch East Indies, and Hansen (1926) says that it is certainly the most common Stomatopod in the Indo-Pacific Region. In Oceania it has been found as far east as Tahiti. Edmondson (1925), who reports seven specimens from Wake Island, does not know of any records from Hawaii. It appears to be absent from New Zealand and the southern coast of Australia. On the west coast of Australia it has been reported recently by Rathbun (1914), Alexander (1916), and Balss (1921).

The only records from the Pacific Coast of America are by Miers (1880, p. 42) and Nobili (1897, p. 6). Nobili later (1901) described his two specimens from Darien as *G. festae*, now regarded as a variety of *G. oerstedii;* and it seems probable that the "small male from Panama . . . and two males . . . from the West American coast," mentioned by Miers, are of that species or its varieties, described below.

List of Specimens

No.	Locality	Sex	Length
S	Apia	♀	68.5 mm.
9*a*	Apia, coral reef	♂	46.0
9*b*	" " "	♀	37.0
9*c*	" " "	♂	32.5
10*a*	Pago Pago	♂	51.0
10*b*	" "	♀	19.0
10*c*	" "	♂	15.0
11	Apia	♀	41.0

Gonodactylus chiragra var. platysoma (Wood-Mason)

Gonodactylus platysoma Wood-Mason, Figs. and Descr. of Nine Squillidae, 1895, p. 11, pl. 3, figs. 3–9.

Gonodactylus chiragra Borradaile, Proc. Zoöl. Soc. Lond., 1898, p. 34, pl. 6, fig. 8.

Gonodactylus chiragra var. *tumidus* Lanchester, Faun. and Geog., Maldives and Laccadives, 1903, **1**, p. 447, pl. 23, figs. 1 and 1*a*.

Gonodactylus chiragra var. *acutus* Lanchester, *ibid.*, 1903, p. 447, pl. 23, figs. 2, 3, and 3*a*.

Gonodactylus chiragra var. F. and G., Borradaile, Trans. Linn. Soc. Zoöl., 1907, **12**, p. 211.

Gonodactylus chiragra var. *tumidus* and var. *acutus* Lenz, in Voeltzkow's Reise in Ostafrica, 1910, **2**, p. 571.

Gonodactylus chiragra var. *tumidus* and var. *acutus* Balss, Denk. K. Akad. Wiss. Wien, 1910 (1912), **87**, Fortsetzung, p. 31.

Gonodactylus chiragra var. *platysoma* Kemp, Mem. Indian Mus., 1913, **4**, p. 162.

Gonodactylus chiragra var. *acutus* Pesta, Denk. k. Akad. Wiss. Wien, 1914, **89**, p. 682.

Gonodactylus chiragra var. *platysoma* Bouvier, Bull. Sci. France et Belg., (7), 1915, **48**, p. 312.

Gonodactylus chiragra var. *platysoma* Kemp, Philip. Jour. Sci., (D), 1915, **10**, pp. 180–182.

Gonodactylus chiragra var. *acutus* Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, pp. 300–302.

Gonodactylus chiragra var. *platysoma* Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111.

Gonodactylus chiragra var. *platysoma* Odhner, Göteborgs Vet. Handle. (4), 1923, **27**, (4), p. 8.

Gonodactylus chiragra var. *platysoma* Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, p. 339.

Diagnosis.— A variety of *G. chiragra* which differs from the typical form in the following particulars: the body is much more depressed and broader, the width of the fifth abdominal segment being more than two fifths the total length of the animal; the dactylus of the raptorial claw is shorter and not at all, or very slightly, bent at the tip; the telson entirely lacks lateral teeth, the lateral marginal carinae tapering evenly and without any interruption to the tips of the intermediate teeth. The carinae of the telson are smooth, the median one having no spine and no anchor-like outgrowths, or at most having them very faintly indicated. The carinae of the sixth abdominal somite and of the telson are narrow in females (Pl. 2, Fig. 2) and young males. In large males they are swollen, the median carinae of the telson becoming very tumid (Pl. 1, Fig. 2).

General Description.— While sorting the material from the Samoan Expedition, I came across five specimens that differ from the associated specimens of *G. chiragra* so strikingly in form of body and in their color pattern that I at once set them aside as representing a new species or variety. Upon comparing them with Wood-Mason's plates, it was at once evident that they are identical with the form that he figured as *G. platysoma*. Unfortunately, his editor was unable to find any description or reference to this species among his notes. This deficiency has recently been supplied by Kemp (1913), who has pointed out the distinctive characters mentioned in the diagnosis above, and has also furnished a table of comparative measurements (1915) showing that in var. *platysoma* the mean ratio of length of carapace to breadth of abdomen is 1.03, whereas in the typical form the mean ratio is 1.22.

In the United States National Museum in Washington, I found one specimen of this variety, No. 45,248, collected by the "Albatross" November 17, 1899, on the fringing reef at Borabora Island in the Society Group. Through the courtesy of Miss Mary J. Rathbun, I was permitted to examine and measure this and other specimens. This is a female 57 mm. long and corresponds in all respects with the specimens from Samoa.

In the summer of 1904, and again in 1910, I had the good fortune to visit the University Museum in Cambridge, England. On the second visit I had with me the specimens from Samoa and was permitted to compare them directly with the ones in the University Museum. There I found nine males and six females of var. *platysoma*, which I examined and measured. Eight measurements were made on each one of five males and six females. The specimens examined included a male figured by Borradaile (1898, pl. vi, fig. 8) as *G. chiragra*, two males labelled "*G. chiragra* var. *tumidus* type," and four females labelled "*G. chiragra* var. *acutus* type." Barradaile's specimen is from Rotuma; the others are Lanchester's types from the Laccadive Archipelago. The other localities represented in the collection at Cambridge are Coin Peros (?), the Loyalty Islands, and the Solomon Islands. The specimens from the Loyalty Islands lacked all color markings except a pair of black spots on the first abdominal somite. It is remarkable that in every other specimen of this variety that I have examined the characteristic pattern is distinctly, and in some cases very well preserved. Lanchester (1903, p. 447) records that his specimens from the Laccadives were accompanied by the following note: "Variegated green and white. The dark patches on the last thoracic segment and the fifth abdominal segment are very characteristic; latter orange red in centre." The

pattern also well shown in Borradaile's figure seems to be highly characteristic of this variety. The typical form of the species (*G. chiragra s.s.*) has several varieties of pattern, all quite different from this one (cf. Pl. 2, Fig. 1), as already pointed out by Kemp (1915).

So far as I am aware, Borradaile (1898) and Lanchester (1903) are the only authors who have taken this variety as representing the typical form of the species. Lanchester is certainly mistaken in citing my work (Bigelow, 1894) among the authorities for that selection, for I had not seen a specimen of this variety until the Samoan collection was put in my hands. Later Borradaile (1907) selected var. A (= var. *incipiens* Lanchester, 1903) as the typical form. I think Kemp (1913, p. 162) is right in following this precedent, and also in setting apart Lanchester's var. *acutus* as a distinct variety under the name var. *platysoma* Wood-Mason. My examination of Lanchester's types shows that his variety *tumidus* should also be included in var. *platysoma*. Komai (1927) suggested that perhaps var. *platysoma* should be restored to the status of a separate species.

Sexual differences in this variety are clearly marked in the sculpturing of the sixth abdominal segment and of the telson. In all females the carinae are narrow (form G= var. *acutus*). In all males that I have examined that are more than 62.5 mm. long, the carinae of these segments, especially the median one of the telson, are more or less swollen, this condition increasing with age (form F = var. *tumidus*). Males of that size or smaller are like the females.

Distribution.— This variety, like the typical form, seems to be an inhabitant of shallow water about coral reefs, and to be widely distributed through the tropical portions of the Pacific and Indian Oceans. The specimens in the Samoan collection are from Apia (one lot labelled "coral reef") and from Pago Pago. Since this collection was made, Pesta (1914) has recorded the capture by Rechinger of two females at Savaii, Samoa; and Komai (1927) reports two males from Jaluit in the Marshall Islands. The other localities, either previously recorded or noted here for the first time, are: Port Blair, Andamans (Wood-Mason's types); Society Islands, Mauritius, and Philippines (Kemp); Mauritius, typical *G. chiragra* collected at the same time (Bouvier); Red Sea (Balss); Rotuma (Borradaile); Minikoi, Laccadives, from the reef (Lanchester); Borabora Island, Society Group, fringing reef, (No. 45,248, U. S. National Museum); Zanzibar and Madagascar (Lenz); Guam and Marquesas (Edmondson); Ryukyu Islands (Parisi). At Samoa and at Mauritius (Bouvier, 1915) the two forms seem to be closely associated.

List of Specimens

No.	Locality	Sex	Length
12*a*	Apia, Samoa	♀	74 mm.
12*b*	" "	♂	64
13	Pago Pago, Samoa	♂	81
14*a*	Apia, coral reef	♀	70
14*b*	" " "	♀	telson lost

Gonodactylus oerstedii Hansen

Gonodactylus chiragra A. Milne-Edwards, Nouv. Arch. Mus. Hist. Nat., 1868, **4**, p. 65.
Gonodactylus chiragra S. I. Smith, Trans. Conn. Acad. Arts and Sci., 1869, **2**, pp. 31 and 41.
Gonodactylus chiragra von Martens, Arch. f. Naturg., 1872, **38**, Bd. I, p. 147.
Gonodactylus chiragra (*pars.*) Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatop., pp. 56–58.
Gonodactylus chiragra Pocock, Journ. Linn. Soc., 1890, **20**, p. 526.
Gonodactylus chiragra Brooks, Mem. Nat. Acad. Sci., 1891, pp. 353–360, pl. 1, fig. 2; pls. 3, 14 and 15.
Gonodactylus oerstedii Hansen, Ergeb. Plankton Exped., 1895, **2**, footnote, p. 65.
Gonodactylus oerstedii Borradaile, Proc. Zoöl. Soc. Lond., 1898, p. 35, pl. 5, fig. 3.
Gonodactylus oerstedii Rankin, Ann. N. Y. Acad. Sci., 1898, **11**, p. 253.
Gonodactylus oerstedii Bigelow, Bull. U. S. Fish Com., 1901, **2**, p. 149, figs. 1, 2.
Gonodactylus chiragra var. *oerstedii* Lanchester, Fauna and Geogr. Maldives and Laccadives, 1903, **1**, p. 455.
Gonodactylus oerstedii Kemp, Mem. Indian Mus., 1913, **4**, p. 204.
Gonodactylus oerstedii Rathbun, Rapp. Visscherij Curacao, 1919, **2**, p. 348.
Gonodactylus oerstedi Kemp and Chopra, Rec. Indian Mus., 1921, **22**, p. 309.
Gonodactylus oerstedi Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 111.
Gonodactylus oerstedii Verrill, Trans. Conn. Acad. Arts and Sci., 1923, **26**, p. 189, pl. 50, figs. 3–4; pl. 51, figs. 2–2*b*.
Gonodactylus oerstedii Schmitt, Bijdr. Dierk. Amsterdam, 1924, **23**, p. 80.
Gonodactylus oerstedii Schmitt, Univ. Iowa Studies Nat. Hist., 1924, **10**, no. 4, p. 96.
Gonodactylus oerstedii Hansen, Siboga-Exped. Monogr., 1926, **35** (Livr. 104), p. 26.

Diagnosis.— A Gonodactylus of Group I having cylindrical eyes; the rostrum transverse with acute median spine elevated somewhat above the rounded lateral angles; sixth abdominal segment with six dorsal carinae, the submedian and intermediate pair being well rounded, more or less elliptical in outline, and often possessing a minute pos-

terior spine, the lateral pair narrow, ending in the strong posterior lateral spines, a transverse carina extending between the ends of the lateral carinae, visible only when the abdomen is flexed; telson with three high rounded central carinae, the median one usually with anchor; submedian marginal teeth large, with minute mobile tips and finely serrated on the inner edge, the total length of the telson being equal to or less than the breadth, intermediate teeth prominent, and lateral pair obsolete; lateral margin sharply carinate, and strong submedian and intermediate marginal carinae, each one of the latter having on its inner side a short *supplementary carina* (Bigelow, 1901, fig. 1, *sc.*), which is attached to the main carina at both ends and separated by a deep groove from the intermediate denticle; the central carinae with or without a *single* terminal spine, and supplementary carinae sometimes slightly serrated; otherwise, the surface of the sculpturings of the telson is smooth and polished. The basal prolongations of the uropods end in two flattened curved spines of which the outer one is the longer and reaches beyond the end of the exopodite; mobile spines of exopodite, straight or curving inward.

General Discussion.— The most abundant species of Gonodactylus in the Atlantic and West Indian region is *G. oerstedii*. It resembles closely the equally abundant typical form of *G. chiragra* of the Indo-Pacific region. It differs chiefly in the possession of a "supplementary," or accessory, carina on the inner side of each intermediate marginal carina of the telson (Hansen, 1895; Bigelow, 1901, fig. 1). This feature appears to be invariably present, except in very young specimens (less than 20 mm., Kemp and Chopra, 1921; 6 to about 12 mm., Hansen, 1926).

On the Pacific coast of America is found a third form to which Nobili (1901) has given the name *G. festae*. It resembles *G. oerstedii* in the arrangement of the carinae of the telson, and differs from both the other two in the possession of numerous spinules on the submedian and accessory marginal carinae and in the form of the rostrum.

G. festae is represented in the present collection, and the discovery of an intermediate form makes it appear to be more properly a variety of *G. oerstedii* than a distinct species.

The intermediate form is found in the West Indies and Atlantic Coast of South America, and has been described by Schmitt (1924) as *G. oerstedii* var. *spinulosus*.

We seem here to have a case analogous to *G. demani* with its varieties *spinosus* and *espinosus*, one of which is widely separated geographically from the others (Kemp, 1913), and is the most aberrant. In the

same way we have *G. oerstedii s.s.* and var. *spinulosus* which occupy the same area; but the variety differs from the typical form in the possession of spinules on the telson, and is intermediate between the typical form and *G. festae*, which is separated from the other variety by the Isthmus of Panama, and differs still further from the typical form in the shape of the rostrum. Therefore, *G. festae* Nobili, which is represented in the present collection by a specimen from Panama, will be described as a variety of *G. oerstedii*.

It is not surprising to find the same species of similar forms with slight differences on the two sides of the Isthmus of Panama, a land barrier that arose during the upper Miocene Period.[1] Similar results were obtained from the study of the species of *Squilla* (Bigelow, 1894). *Squilla intermedia* is an Atlantic form, and two closely related species, *S. panamensis* and *S. biformis*, are probably entirely confined to the Pacific Coast of America (*cf.* Calman, 1917, p. 140). The wide stretch of open sea between the archipelagos of the southern Pacific and the shores of America seems to be a more efficient barrier than a comparatively recent land mass like the Isthmus of Panama. Thus we have *G. chiragra* and its variety *platysoma* occupying a wide area in the Indo-Pacific region, but unknown in Hawaii and on the shores of the American Continent. In the same way, *G. oerstedii* and its varieties *festae* and *spinulosus* occupy similar stations in the western Atlantic, West Indies, and Pacific shores of tropical America.

In the three species of *Squilla* it is the intermediate one that is separated by the impassible barrier. This does not seem to be the case with the varieties of *G. oerstedii*, which thus seem to furnish an exception to Jordan's law of distribution.

Size.— The largest specimen of *G. oerstedii* in the Porto Rico collection is a male 53 mm. long and there were fifteen specimens over 40 mm. long.

Distribution.— The typical form of this species is widely distributed in shallow water on the shores of the mainland and islands of the Atlantic Coast of tropical America, as was indicated by Smith (1869), who had examined specimens from the Bermudas, Florida keys, Aspinwall (now Colon), and Caravellas and Abrolhos in Brazil. There are numerous records from the Bahamas and islands of the Caribbean Sea and the Gulf of Mexico. Pocock (1890) records the occurrence of this species at Fernando Noronha in the south Atlantic, and Rathbun gives its northern limit as North Carolina. It has also a limited distribution

[1] There may have been a narrow connection between the Atlantic and the Gulf of California during the Pliocene (Vaughan, 1919, U. S. Nat. Mus. Bull., *103*, p. 611).

on the Pacific Coast; Kemp and Chopra (1921) have examined specimens from the Paris Museum collected at a depth of 15–25 m. at Espiritu Santo in the Gulf of California, and Hansen (1926) states that Dr. Th. Mortensen secured many specimens in the Gulf of Panama, thus confirming the previous records of Miers (1880) and Nobili (1897). According to Verrill (1923) it has been reported from West Africa by Benedict and Rathbun, but I am assured in a letter from Dr. W. L. Schmitt that this is an error, and it is not included in the list of West African species given by Monod (1925).

Gonodactylus oerstedii var. spinulosus Schmitt

Gonodactylus oerstedii var. *spinulosus* Schmitt, Univ. Iowa Studies Nat. Hist., 1924, **10**, pp. 96–98, pl. 5, fig. 5.

Gonodactylus oerstedii (*pars*) Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 27, fig. 104).

Diagnosis.— A variety of *Gonodactylus oerstedii* differing from the typical form in the following points: (1) the median spine of the rostrum is hardly long enough to reach the cornea, the anterior margins are nearly straight and transverse or slope backward, and the anterolateral angles are rounded and depressed, not covering any part of the eye-stalks; (2) the telson bears numerous spinules on the dorsal surface, which are variable in position, but may be found upon the submedian central carinae, the anchor, the submedian marginal carinae, the accessory carinae, and not far from the margin of the telson near the apices of the median and intermediate notches; (3) the exopodite of the uropods is slightly longer than the basal prolongation and at least two of the mobile spines are distinctly recurved.

Discussion.— The diagnosis of this variety, not represented in the present collection, is introduced here because of its relation to var. *festae*. The type specimens were collected at Barbados by an expedition from the University of Iowa. A male specimen 34 mm. in length taken by the "Fish Hawk" at Playa de Ponce Reef, Porto Rico, in 1899, not distinguished from the typical form in the report on that collection (Bigelow, 1901), agrees in all essentials with the description of the type. Moreover, in the United States National Museum there are three females (No. 18,490) taken by the "Albatross" at station 2,758 off Cape St. Roque, Brazil, that are similar to the male from Porto Rico.

The characteristic black markings on the latter, described by Schmitt as resembling Chinese ideographs, are on the dorsum of the sixth thoracic and first abdominal somites, not on "the first and fourth

abdominal somites" as described for the type (*cf.* Kemp '13, fig. 1, p. 12; or Bigelow, '94, fig. 13). The mandibular palp is divided into three segments and in length equals more than a quarter of the carapace.

In the shape of the rostrum the typical form of the species appears to be intermediate between var. *spinulosus* and var. *festae*. In the specimen of var. *spinulosus* from Porto Rico the anterior margins extend nearly straight across to the antero-lateral angles, which are rounded and depressed. The three females, about 25 mm. long, from Cape St. Roque, have more obtuse angles, the anterior margins of the rostrum slanting distinctly backward.

On the telson of the male the three central carinae are much swollen and appear highly arched in lateral view. In the smaller females they are narrow and rounded, with a terminal spine, of which there is merely a trace in the male, on the median carina. There are slight variations in the number and arrangement of the spinules.

Distribution.— Barbados, *type;* coast of Brazil, "Albatross" station 2,758 off Cape St. Roque; Porto Rico, "Fish Hawk" Playa de Ponce Reef; Virgin Islands (?) and Gulf of Panama (?) Hansen (1926).

Gonodactylus oerstedii var. festae (Nobili)

Gonodactylus chiragra Nobili, Bol. Mus. Zoöl. Anat. Univ. Torino, 1897, **12**, no. 280, p. 5.

Gonodactylus festae Nobili, Bol. Mus. Zoöl. Anat. Univ. Torino, 1901, **16**, no. 415, p. 53.

Gonodactylus chiragra var. *festae* Lanchester, Faun. and Geog., Maldive and Laccadive Arch., 1903, **1**, p. 456.

Gonodactylus festae Borradaile, Trans. Linn. Soc. (2) Zoöl., 1907, **12**, p. 219.

Gonodactylus festae Rathbun, Proc. U. S. Nat. Mus., 1910, **38**, p. 608.

Gonodactylus festae Kemp, Mem. Indian Mus., 1913, **4**, pp. 148, 153, p. 204.

Gonodactylus oerstedii (*pars*) Hansen, Siboga-Exped. Monogr., 1926, **35** (Livr. 104), p. 27.

Diagnosis.— A variety of *Gonodactylus oerstedii* having mandibular palps composed of three segments; dactylus of raptorial claw greatly inflated at the base and strongly flexed inward at the tip; rostrum with strong median spine, acute and extending to the cornea of the eyes, and antero-lateral angles of the rostrum produced into strong acute spines; sixth abdominal somite with six carinae terminating in spines; the telson has three central carinae, the median one with anchor flukes and all with or without terminal spines; submedian and intermediate

marginal teeth well developed, the lateral ones obsolete or absent; the dorsum of each submedian tooth bears a longitudinal carina, while the corresponding area of the intermediate teeth is occupied by a groove surrounded by two carinae, the inner (accessory) one being somewhat lower and shorter than the outer one, which forms an outwardly convex curve; the lateral margin is also carinate. The submedian and the accessory intermediate marginal carinae bear spinules on the dorsal surface.

General Description.— The collections of the Eastern Pacific Expedition of the "Albatross" contain a single specimen that may be referred to this variety. It is a female (E.P. 54) 34 mm. long, taken at Perico Island, Gulf of Panama, October 26, 1904 (Pl. 2, Fig. 3 and 4). This specimen and those described by Hansen (1926) are the only ones known in addition to the types collected by Dr. Festa and deposited in the museum of the University of Turin. Nobili's description of these is brief, but is sufficient to distinguish this form clearly from the typical forms of *G. chiragra* and *G. oerstedii*. It is like the latter in having an accessory carina on each intermediate marginal tooth of the telson, and it differs from both in having strongly produced acute lateral angles on the rostrum and in the presence of minute spinules on the marginal carinae of the telson. Nobili (1901) states that the spinules on the submedian marginal carinae are in two series.

Our specimen differs in that the submedian, like the accessory, marginal carinae bear only a single row of spinules. The intermediate marginal carinae are smooth. In this specimen the three central prominences are peculiar in shape (Pl. 2, Fig. 3). The base of each one is fairly broad, and is separated by a longitudinal groove on each side from the summit, which is narrow throughout and more or less angular or slightly produced at the posterior end. The grooves on the median prominence are bounded laterally by the flukes of the "anchor," and by low narrow ridges, one on each side, that connect the flukes with the two small tubercles, often observed in other species, lying close to the anterior end of the median carina. Below the posterior end of the median carina are two angular elevations, ending in minute posterior spinules. There are two well developed tubercles near the anterior margin of the telson, in line with the intermedian spines of the sixth abdominal somite. The eyes are cylindrical and rather large, the length of eye stalk being equal to 0.35 the length of the carapace. The ophthalmic somite is short and well covered by the rostrum; the dorsal processes are inconspicuous. The carapace is somewhat narrowed anteriorly; the anterior angles extend forward and are well

rounded; the posterior margin is nearly straight. The exposed thoracic and first five abdominal somites present no features of special interest. The latter have the usual carinae on the lateral margins which are rounded posteriorly.

The antennal scale is large, equalling half the length of the carapace. The propodus of the raptorial limb is moderately dilated at the distal end. The dactylus is evenly and very strongly inflated at the proximal end and the slender distal part is conspicuously inflexed.

The uropods are similar to those in *G. chiragra*. The basal prolongation is divided into two strong prongs, the longer outer one being unarmed and extending to the end of the exopodite. The basal segment bears a strong spine at the articulation of the exopodite. There is no spine guarding the articulation with the body.

Before the discovery of intermediate forms *G. festae* Nobili seemed clearly to be a species quite distinct from *G. oerstedii*. Reëxamination of the Porto Rico collection brought to light a specimen that had been overlooked. Its rostrum has rounded antero-lateral angles as in *G. oerstedii*, and its telson is spinulous as in *G. festae*. More recently Schmitt (1924) has described very similar specimens from Barbadoes under the name *G. oerstedii* var. *spinulosus*, as noted above (p. 123). We must, therefore, agree with the opinion of Hansen (1926), based on the study of specimens from the Virgin Islands and the Gulf of Panama in European museums, that *G. festae* is a variety of *G. oerstedii*.

Color.— The only indications of color pattern in our alcoholic specimen are a large number of minute black spots that show an irregular tendency toward bilateral symmetry in their arrangement. There is a row of three irregular clusters on the carapace, and a loose cluster on the middle of the sixth thoracic and the first abdominal somites, and scattered spots on these and other segments.

Distribution.— The present specimen was taken at Perico Island, Gulf of Panama. Nobili (1901) records the discovery of this variety at Darien and on the coast of Ecuador at Punta St. Elena and Baia de St. Elena. He explains (1897, p. 6) that specimens labeled "Darien" by Dr. Festa were taken in San Miguel Bay, Gulf of Panama, not in the Gulf of Darien on the Caribbean side of the Isthmus, as might be supposed. At least one of the spiniferous specimens described by Hansen (1926, p. 27) appears to belong to this variety, but he does not state whether it was taken at the Virgin Islands or in the Gulf of Panama.

Table of Measurements

Specimen No. E. P. 54 ♀	mm.	ratio
Length median line, total length	33.0	
Length rostrum	2.7	
Ratio length of rostrum to total length	—	0.08
Ratio width to length of rostrum	—	1.00
Ratio length of carapace to total length	—	0.25
Ratio anterior width to total length	—	0.15
Ratio width fifth abdominal segment to total length	—	0.20
Width telson	6.0	—
Ratio maximum length telson to total length	—	0.15
Ratio maximum length telson to width of telson	—	0.80
Ratio depth of telson to width of telson	—	0.48

Gonodactylus glabrous Brooks

Gonodactylus glabrous Brooks, Voy. H. M. S. "Challenger," Zoöl., 1886, **16**' (45), p. 62, pl. 14, fig. 5; pl. 15, fig. 7, 9.

Gonodactylus glaber Henderson, Trans. Linn. Soc. Zoöl., (2), 1893, **5**, p. 454.

Gonodactylus glabrous (incl. var. *ternatensis*) de Man, Abh. Senck. Nat. Ges. Frankfurt, 1902, **25**, pp. 913–914, pl. 27, fig. 67.

Gonodactylus chiragra var. *glabrous* and var. *mutatus* Lanchester, Fauna and Geogr. Maldive and Laccadive Arch., 1903, **1**, pp. 448, 451, pl. 23, figs. 8, 9, 15.

Gonodactylus graphurus Nobili, Bull. Sci. France et Belg., 1906, **40**, p. 159.

Gonodactylus glaber (incl. var. *ternatensis* and var. *rotundus*) Borradaile, Trans. Linn. Soc. Zoöl., (2), 1907, **12**, pp. 211, 212.

Gonodactylus chiragra var. *glabrous* Balss, Denk. Math.-Nat. Kl. K. Akad. Wiss. Wien., 1910 (1912), Reprint (1910) of **87**, Fortsetzung . . ., pp. 31–32, fig. 5.

Gonodactylus glabrous Kemp, Mem. Indian Mus., 1913, **4**, pp. 167–169, 197–198; pl. 9, fig. 113 and text fig. 2, p. 170 (incl. complete bibliography to 1910).

Gonodactylus glabrous Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 313.

Gonodactylus glabrous Kemp, Philip. Jour. Sci. (D), 1915, **10**, pp. 182–183.

Gonodactylus glabrous Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, **1**, p. 10.

Gonodactylus glaber Tattersall, Jour. Linn. Soc. Zoöl., 1921, **34**, p. 362.

Gonodactylus glabrous Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, pp. 112–114, fig. 7.

Gonodactylus glabrous Odhner, Göteborgs Vet. Handl., (4), 1923, **27**, (4), p. 8.

Gonodactylus glabrous Hansen, Siboga-Exped., 1926, **35**, pp. 29–30.

Gonodactylus glabrous Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, p. 340.

Diagnosis.— A *Gonodactylus* of Group I, having on the dorsum of the telson a central eminence bearing five longitudinal carinae, of which the outer pair (second submedian) is the smallest; lateral marginal teeth distinct and acute; first five abdominal somites smooth except for a distinct pit on each side near the customary L-shaped groove; carapace with sides nearly straight and parallel, and nearly straight gastric grooves diverging from the anterior to the posterior margins, so that the lateral portions of the carapace are rhomboidal; dorsal processes of the opthalmic somite small and rounded; raptorial propodus without movable spine, the dactylus moderately inflated at the base and the slender distal part strongly flexed, the tip usually with a distinct reversed curve, frequently marked on the outer margin by a distinct, although minute, angle; the basal process of the uropods with a small denticle on the inner side of the outer spine near its base; the proximal segment of the exopodite with two sharp longitudinal carinae, of which the inner is slightly shorter than the median one; the outer margin also carinate, the endopodite with a sharp longitudinal carina near the outer margin, which is upturned so that the fringe of setae on this side point upward nearly at a right angle to the fringe on the inner side.

General Description.— Lanchester (1903) regards this species as a variety of *G. chiragra*. The basis for this view is the fact that in certain small specimens of *G. chiragra* the anchor flukes were found to be separate from the median carina of the telson, and thus seemed to present an intermediate condition (var. *segregatus*). Lanchester relies entirely upon the variability of the central carinae. I quite agree with Kemp (1913) that in reality there is no justification for uniting the two species on this ground. No specimen has come under my observation which could not be classified in one or the other of these species by characters of the telson alone. In specimens of all sizes of *G. glabrous*, the submedian carinae of the telson are sharply separated from the median one and are longer and more elevated than the outer, or second submedian, pair; and the lateral marginal teeth are always sharply defined. But even if the telson were destroyed, there are numerous other differences by which the species can be recognized. Some of these have been noted by Kemp. He states that *Gonodactylus glabrous* differs from *G. chirgara* only in the following characters:

1. The small size and rounded margin of the dorsal processes of the ophthalmic somite.
2. The absence of the small movable spine on the raptorial propodus.

3. The presence of a rather conspicuous pit on the side near the anterior margin of the 2d, 3d, 4th, and 5th abdominal somites.
4. There are *five* long carinae in the middle of the dorsal surface of the telson, and immediately behind the median there is a small pair of tubercles. The lateral marginal teeth are more distinct than in *G. chiragra*.
5. There is a small denticle on the outer spine of the basal process of the uropods.

The small tubercles referred to in paragraph 4 are, I suppose, a pair situated on a curved elevation which is separated from the median carina by a deep groove. There is also a pair of tubercles on the posterior end of the median carina in the position of the flukes of *G. chiragra* and separated from the spine by a pit. Similar pits occur under the spines of the submedian carinae of the telson and under the submedian and intermediate spines of the 6th abdominal segment. Under the intermediate spines of the sixth somite and the submedian of the telson the pit is not symmetrical with the axis of the spine but is on its median side, and on the telson the outer border of the pit is usually elevated into a small tubercle which may be considerably elongated in a curved direction behind the spine. These points are not clearly shown in the otherwise excellent figure by de Man (1902, pl. 27, fig. 67). I may add that in practically all of the specimens that I have examined there are well developed spines on all six carinae of the sixth abdominal somite and on the three central ones of the telson. Where spines were absent careful examination has generally shown that they were broken off. In *G. chiragra* there is frequently no trace of spines on the central carinae of the telson, and I have seen no indication of the pits beneath the spines.

There are a number of other differences between *G. glabrous* and *G. chiragra*. Some of them have been mentioned in the diagnosis above. On the telson of *G. glabrous* the tubercles near the anterior margin are more conspicuous, often appearing as "sharply defined carinae" (Brooks). The lateral marginal teeth are very distinct and acute in all my specimens, the notch on the inner side of this tooth generally being deep and bordered by a well defined elevation of the margin.

The uropods of *G. glabrous* present striking peculiarities that seem to have escaped notice. The endopodite has a complete fringe of setae, but this does not lie flat as in *G. chiragra*. On the contrary, the whole outer edge of this segment is turned sharply upward and the setae inserted in this part point dorsally, nearly at a right angle to the fringe on the inner edge. Also, on the dorsal surface there is a sharp longitudinal

carina close to and parallel with the outer margin. In *G. chiragra* the corresponding position is occupied by a low, rounded thickening and the margin is not at all upturned, or very slightly so, at the proximal end.

In the uropods of *G. chiragra* the proximal segment of the exopodite has a single longitudinal dorsal ridge, and there is on the inner side a slight rounded elevation which in small specimens may be carinate for a short distance near the proximal end of the segment. In *G. glabrous* of all sizes this inner carina is well developed, so that there are on this segment two sharp longitudinal ridges of which the inner one is only slightly the shorter. There may be also a sharp thickening of the outer margin, which is not present in *G. chiragra*. The terminal fixed spine is very short in *G. chiragra*; in *G. glabrous* it is half as long as the distal mobile spine. In both species the terminal movable spine is straight and reaches to about the end of the terminal segment, but in *G. chiragra* the two or three spines next to the terminal one are more or less recurved and flat, while in *G. glabrous* they are not at all recurved but are, with the rest of the series, distinctly curved upward toward the tips.

Equally striking are the differences in the carapace. In the typical form of *G. chiragra* the carapace is narrowed anteriorly with nearly straight sides and straight gastric grooves running parallel to the sides. In var. *platysoma* the sides of the carapace are not straight but bend inward at the anterior third, and the gastric grooves are not straight but are bent outward at the cervical node. In *G. glabrous* the sides of the carapace are nearly straight and parallel to each other, and the gastric grooves are also nearly straight but not parallel to the sides, which they approach posteriorly, so that the lateral areas of the carapace gradually become narrower from the anterior margin backward.

The tip of the raptorial dactylus is rather variable. In some specimens from the Philippines it is practically of the same form as in *G. chiragra*. In others from that region, and in practically all from Samoa it is of the form to be seen in Figure 1. There is a pronounced outward turn to the point, and on the outer surface the point of inflexion is marked by a distinct angle. The tip is frequently broken, which gives a deceptive appearance.

There is great variation in the rostrum. In some specimens the median spine reaches to the cornea of the eyes, in others it is so short as to barely overlap the base of the eye-stalk. In the form of the lateral angles there is a nearly constant difference between specimens from Samoa and those from the Philippines. In the Samoan specimens the

maximum length of the rostrum is generally considerably greater than the width at antero-lateral angles. The anterior margins on each side of the spine are nearly transverse and the antero-lateral angles are broadly rounded. In the Philippine specimens the length and breadth are about equal, the anterior margins are usually directed obliquely forward from the junction with the spine and the antero-lateral angles are narrowly rounded or subacute.

According to Kemp the only characteristic by which this species can be distinguished from the closely related *G. graphurus* Miers is the absence of transverse and longitudinal grooves on the sides of the first five abdominal somites (Brooks 1886, pl. 414, fig. 1 and Kemp, 1913, p. 170, text figs. 1 and 2). I too have found no indication of these grooves in any specimen I have examined. On the other hand, they

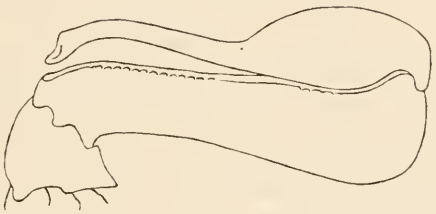

FIG. 1.— *Gonodactylus glabrous* Brooks, female, 58 mm., from Apia coral reef (No. 15a). Raptorial limb (right), showing the dactylus of the typical Samoan form with an outward turn at the apex and an angle at the point of inflection. Length of dactylus, 9.05 mm.

were perfectly constant in numerous specimens of *G. graphurus* examined by Pocock (1893, p. 475), except in one very small (10 mm.) individual. Brooks states that in *G. glabrous* the paddles of the exopodites of the uropods are less than half as long as the second joint. They are longer in my specimens. The proportions of length to breadth of the telson are variable. Some of the other characters that Brooks mentions as distinctive are sexual. He described the species from a single female specimen.

There is considerable variation in the sculpturing of the sixth abdominal somite and of the telson, including an evident sexual dimorphism. In all specimens the submedian and intermediate carinae of the sixth abdominal somite are triangular in outline, the apex terminating in the strong posterior spine. The upper surface of these carinae is more or less flat, and slopes forward to the general surface of the somite

just behind a prominent transverse ridge that borders the whole of the articular membrane, and is not completely covered by the posterior edge of the somite in front, even when the abdomen is fully extended. The lateral carinae of the sixth abdominal are narrow, and in females, flattened on top. All the carinae of the telson are more or less rounded above. In young specimens of both sexes less than 35 or 40 mm. in length the carinae are generally narrow and sharp, each ending in a strong spine, and there is no sexual dimorphism. In larger specimens of both sexes there is a tendency toward a broadening of the carinae, with a decrease in the proportionate size of the terminal spines. This tendency is most conspicuous in the males. In a typical adult female over 35 mm. long, the carinae of the sixth abdominal somite are distinctly flattened on the upper surface, which makes a sharp angle with the steep sides. The central carinae of the telson also have steep sides and the valleys between, as seen in posterior view, are wider than the carinae. In a typical male the submedian carinae of the sixth abdominal somite are rounded on top, and on all the carinae of this somite the angles are more rounded than in the female. All the carinae of the telson are broader and more rounded than in the female. The central carinae are much swollen with sloping sides, and the valleys between, as seen from behind, are not wider than the carinae.

There is considerable variation in both sexes. In females of the same size, some will have the central carinae of the telson sharp and narrow (Brooks, 1886, pl. 14, fig. 5) and others will have broader ones (de Man, 1902, fig. 67). Some males have central carinae differing little from the maximum in the females; in other individuals of the same size, they are much broader and swollen, although the maximum tumidity in the females approaches the minimum of the males. I have not found a single pair of individuals of equal size in which the difference could not be detected with more or less ease. Balss (1910*b*) has found a sexual dimorphism in the color pattern (see below).

Several authors have attempted to divide *G. glabrous* into varieties based on differences in the sculpturing of the telson. De Man (1902) founded the var. *ternatensis* on a female with broader form of carinae. Lanchester (1903) recognized that in this species, which he regards as a variety of *G. chiragra*, there is continuous variation, but he failed to notice the effects of age and sex. For his "term *a*," minimum tumidity, he refers to the specimen described by Brooks, a female. His "term *b*," maximum tumidity, is a male (Lanchester, pl. 23, fig. 15). None of my specimens shows so high a degree of tumidity as is represented by his figure of this specimen. According to my view "term *b*♂" would

be very different from "term b ♀", which is accurately illustrated by his Figure 8, and corresponds exactly to de Man's var. *ternatensis*. He separates as var. *mutatus* a number of small specimens of both sexes from the Maldive Archipelago. All of these are under 40 mm. long, all but two under 31 mm., and yet the "carinae are very swollen", whereas all my specimens under 30 mm. long have very narrow carinae. This suggests that in var. *mutatus* we may have a distinct dwarf variety, such as I have reason to think may occur in *G. chiragra*. Borradaile (1907) has divided the species into two varieties: (1) var. *ternatensis* de Man, 1902 (= *ternatensis* de Man + *glaber* type de Man = *mutatus* Lanchester + *glaber* (*pars*) Lanchester) — carinae narrow or of moderate width, not touching one another, spines present at the ends of the three middle carinae of the telson; (2) var. *rotundus* Borradaile (= *glaber* (*pars*) Lanchester) — carinae broad and swollen so as to touch one another, spines of the three middle carinae of the telson obsolete or absent. In Cambridge University Museum there were, at the time of my visit, three specimens labeled "*Gonodactylus glaber* var. *rotundus* Borr. cotypes." These were all males, 40, 41 mm. from Coetivy, 33 mm. from Zanzibar. There were also seventeen specimens labeled by Borradaile "*G. glaber* type var.", or "*G. glaber* var. *ternatensis* de Man (Borradaile, 1907)." These were all females, with the exception of three small males, 36, 28.5, and 22 mm. long. Borradaile's illustration of var. *tumidus* (1907, pl. 22, fig. 2) is surprising when compared with my specimens, none of which has anything like the broad, rounded intermediate teeth on the telson shown in that figure. If the figure be correct it may represent a distinct variety. Kemp (1913) notes the high degree of variability in this species, but states (p. 154) that there can be no doubt that the variation is continuous, and he urges the same objections as in the case of *G. chiragra* to the use of special names to designate particular varietal phases. He observes that among the Ceylon specimens, which form the vast majority of those he examined, "a spineless form with moderately or greatly swollen keels seems to preponderate." As stated above, nearly all the specimens that I have examined from Samoa and the Philippines have spines on the three middle carinae of the telson, and the carinae are narrow or moderately swollen.

Color.— Kemp (1913) reports that his specimens from Ceylon, preserved in formaldehyde and examined not long after capture, showed great variation in color. "The commonest shade was a uniform olivaceous yellow, while other examples were dull purple, deep purplish green profusely mottled, dark olive, olive brown with pale marbling,

brick red, or dull orange. On the last abdominal segment a pair of very small black spots were constantly found close to the anterior margin, situated one on either side, between the submedian and intermediate keels. The keels in this somite and on the telson were in most cases defined by a darker tone." My specimens likewise show evidence of great variation in color and pattern, although preserved in alcohol. The black spots on the sixth abdominal somite, noted by Kemp, are almost invariably present, and in addition there are usually two similar spots on the telson anterior to the second submedian carinae, as observed by de Man (1902, p. 914). Balss (1910 *b*) finds constant differences between the color pattern of the two sexes in a large collection from the Red Sea. The males are spotted with black, while the females are quite clear.

Distribution.— All the specimens in the present collection were obtained at Apia, Samoa — one lot at least from the outer coral reef. This appears to be the first record from Samoa, but the species is a common one, distributed widely in shallow water throughout the Indo-Pacific region. The type locality is Zamboanga, Philippine Islands, and Kemp (1915) records this species from a number of localities in that region. From there it extends north to Misaki in southern Japan (Komai, 1927). The Siboga Expedition (Hansen, 1926) found this species on the coral reefs and down to 59 meters at twenty-one stations in the Dutch East Indies, from Lombok in the west to the Aru Islands in the east, and from the south coast of Timor to North Ubian in the Sulu Sea. Alexander (1916) reports it from Sharks Bay, Western Australia, and Bouvier (1915) from Mauritius. Kemp (1913) gives a long list of stations in the Indo-Pacific region at which specimens have been taken, from Rotuma in the east, westward and south to Ibo in Portuguese East Africa. Odhner (1923) reports it from Fiji, the Gilbert, Marshall, and Bonin Islands, where it is often the most abundant stomatopod. Tattersall (1921) says that it is the commonest stomatopod in the Red Sea. According to Kemp (1913) it is the only species of *Gonodactylus* of which there is an authentic record of occurrence in the Mediterranean, Steuer (1911, p. 734) having found specimens in Heller's collection obtained at Lesina in Dalmatia. The doubt expressed by Hansen (1926) as to the correctness of this locality may be unwarranted in view of the statement by Parisi (1922), that four specimens in the Milan Museum, collected at Nice by C. Bellotti about 1885, confirm absolutely the presence of this species in the Mediterranean.

Habitat and Breeding Habits.— The majority of collections are re-

ported from coral reefs. On the Ceylon pearl banks in the north of the Gulf of Manaar, where this species occurs in profusion, vastly exceeding *G. chiragra* (Kemp, 13, p. 169), the specimens were for the most part found in crevices and holes in coral blocks. Many females with egg masses were found, and the breeding habits of this species appear to be similar to those of *G. oerstedii* observed by Brooks, but the evidence appears to be against the view that the female digs her own burrow (Kemp, 1913, p. 197–98).

Size.— The largest specimens in the present collection are a male 52 mm. and a female 66.5 mm.; the smallest is a female 20 mm. long. Hansen's largest specimen measured 78 mm. Kemp reports a range in size from 14.5 to 98 mm.

List of Specimens

All from Apia, Samoa

No.	Sex	Length
15*a*	♀	58.0 mm.
15*b*	♂	46.0
15*c*	♂	52.0
15*d*	♀	45.0
15*e*	♀	48.3
15*f*	♀	41.0
15*g*	♀	39.5
15*h*	♀	37.0
15*i*	♀	38.5
16*a*	♀	66.5
16*b*	♂	47.5
16*c*	♀	53.5
17	♂	42.0
18*a*	♀	57.5
18*b*	♀	39.0
18*c*	♀	20.0
19	♀	47.5

GROUP III, Kemp, p. 146

Diagnosis.— Anterior margins of the carapace not sloping forward, antero-lateral angles not in advance of the rostral base; rostrum typically trispinous; mandibular palp with two segments; posterior margin of 6th abdominal somite concave [1] in dorsal view; proximal

[1] Kemp, '13, p. 148. The word "convex," *ibid.*, p. 146, is a slip of the pen.

segment of the exopodite of the uropod articulates terminally with the ultimate segment, and on its outer edge is armed with straight movable spines, endopodite normal.

Type Species.— *G. trispinosus* Dana.

Species Represented in the Collection.— *Gonodactylus glyptocercus* Wood-Mason; *Gonodactylus guerinii* White.

Gonodactylus glyptocercus Wood-Mason

Gonodactylus glyptocercus Wood-Mason, Proc. As. Soc. Bengal, 1875, p. 232; reprinted (1876) in Ann. Mag. Nat. Hist. (4), **17**, p. 263.
Protosquilla cerebralis Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p. 72, pl. 14, figs. 2, 3; pl. 16, figs. 2, 3.
Protosquilla glyptocerca Brooks, *ibid.*, 1886, p. 75.
Protosquilla cerebralis Borradaile, Proc. Zoöl. Soc., 1898, p. 33, pl. 5, fig. 6*a*.
Protosquilla cerebralis Fukuda, Annot. Zoöl. Japon., 1910, **7**, p. 139.
Gonodactylus glyptocercus Kemp, Mem. Indian Mus., 1913, **4**, p. 186 (*ubi syn*).
Gonodactylus glyptocercus Kemp, Philippine Jour. Sci. (D), 1915, **10**. p. 186.
Gonodactylus glyptocercus Kemp and Chopra, Rec. Ind. Mus., 1921, **22**, p. 311.
Gonodactylus glyptocercus Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, (4), p. 13.
Gonodactylus glyptocercus Hansen, Siboga Exped. Monogr., 1926, **35** (Livr. 104), p. 36.
Gonodactylus glyptocercus Komai, Mem. Col. Sci. Kyoto Imp. Univ. (B), 1927, **3**, p. 341.

Diagnosis.— A *Gonodactylus* of Group III (Kemp) with large cylindrical eyes, corneal portion very slightly dilated, hemispheroidal; dorsal processes of the ophthalmic somite large and hood-shaped; dactylus of the raptorial limb strongly swollen at the base; rostrum sharply trispinus with lateral spines curved forward; carapace nearly quadrate, its breadth about two-thirds the length; dorsal surface of hind body smooth, except the fifth and sixth abdominal somites and telson, which exhibit a bilaterally symmetrical pattern of fine grooves, low ridges, and rounded bosses peculiar to the species. The pattern on the fifth abdominal somite consists of two parallel longitudinal grooves near the median line, and on each side ten or twelve irregular longitudinal grooves frequently bifurcated, running on the dorsum obliquely posterior-dorsally and on the sides curving ventrally. The sixth abdominal somite is very short in the median line and is firmly fused to the telson, the boundary between the two being marked by a groove that is strongly convex anteriorly. The dorsal surface is covered by convoluted rounded ridges, higher than on the fifth somite. Of these a

submedian pair of U-shaped and an antero-lateral pair of S-shaped ridges are most conspicuous. The telson has three central bosses, a median one, subtriangular in outline, and two submedian oval ones. All have moderately high, smooth, rounded summits and on the sides fine grooves running upward from the narrower furrows that bound them, except on the posterior ends whence low ridges extend to the margin of the telson. On each side between the central elevations and the lateral margin are four blunt longitudinal ridges, the marginal one being grooved in its anterior half. The telson is wider than long, and has a very deep and narrow median fissure, the sides touching; has three pairs of broad marginal teeth, acute at the apex; a slender mobile spinule about three times as long as the denticles on the submedian tooth and articulated on the margin between the distal one of this series and the apical portion. Denticles, 9–11, 1, 1. Basal process of the uropods divided into two spines, the inner one more than half the length of the outer; proximal segment of the exopod bears 8–10 movable spinules.

General Description.— This species was first adequately described and figured by Brooks (1886) under the name *Protosquilla cerebralis*. He suggests, however, that it may be identical with *Gonodactylus glyptocercus*, briefly described by Wood-Mason (1875). Kemp (1913) has compared the figures and description given by Brooks with Wood-Mason's type specimen, and finds the identity to be complete. The reason for rejecting the generic name *Protosquilla* has been discussed on a previous page.

This seems to be a small species. Of the eleven specimens collected by the "Albatross" at Pago Pago the largest, a female, is 28.7 mm. in length from the tip of the rostrum to the end of the telson, the largest male is 22.5 mm. in length. The specimen from Fiji described by Brooks was 32.3 mm. long, while in the collection in the Indian Museum the range is from 10.5 to 29 mm. Hansen (1926) reports that the largest specimen taken by the Siboga Expedition is 35 mm. long.

The specimens in the present collection agree in all essential features with the description given by Brooks and emended by Fukuda (1910) and by Kemp (1913).

They differ in some minor details. The eyes appear to be larger. Measured from the tip to the outer margin of the base, they are nearly half as long as the carapace. The median spine of the rostrum does not reach half the length of the eye-stalks, but only a little beyond the inner margin of the base.

Between the rostrum and the bases of the eye-stalks are the con-

spicuous dorsal processes of the ophthalmic somite. These are hood-shaped; the arched anterior margins appear nearly transverse in dorsal view, and touch the rims of the base of the eye-stalks when the eyes are raised. Their antero-lateral angles are acute.

Brooks describes the carapace as a little longer than wide, while according to Kemp its length in the median line is more than one and one half its breadth at the antero-lateral angles. In one specimen the anterior width is on the average seven-tenths of the length.

Kemp notes that the outermost of the spinules (denticles) on the convex margins between the submedian teeth of the telson are larger than the rest. In reality these larger spinules, which are three times as long as the true fixed denticles, do not belong in that series. They are movably articulated to the margin or slightly under it on the ventral side, and are similar to mobile spinules found in a similar position in several species of *Lysiosquilla*. They may be characteristic of Group III of the genus *Gonodactylus*. In addition to these, the submedian teeth have minute mobile tips. In our specimens the tips of the other teeth are also soft and turned upward. If this represents the condition in life, it suggests a sensory function.

On the exopodite of the uropod, I find nothing to suggest the curved line of spinules mentioned by Brooks. The arrangement of the mobile spines on the proximal segment is quite normal. At the distal end of this segment there is a fixed spine half as long as the distal mobile spine.

Color.— In their color pattern the specimens in the collection divide themselves into two groups as described by Kemp. A majority of them are pale with scattered stellate black pigment cells distributed generally over the surface, but absent on the dorsal surface of the sixth abdominal somite and telson, on the dactylus of the raptorial limb, and on the distal parts of antennae and walking legs. The complete pattern consists also of a series of median patches of dark pigment, single or paired, on the sixth and seventh thoracic and first and fourth abdominal somites, and a lateral patch on each side of the sixth thoracic. One or more of the median patches may be absent. In the smaller group pigment cells are absent on the dorsal surface of the sixth abdominal somite and the telson and the other parts mentioned above. The rest of the body is uniformly dark mottled brown. There is no correlation between these differences and sex. No record has been made of the color of the living animals.

Distribution.— On the South Pacific Expedition of the "Albatross" in 1902 there were taken during July and August four males and seven females, all at Pago Pago, Samoa. This is the most eastern record for

the species. On the west it has been taken at the Nicobars (*type*, Wood-Mason) and at the Andamans and the Mergui Archipelago (Kemp, Kemp and Chopra). It ranges north to Okinawa, in the Kiu Kiu Islands of Japan (Fukuda, Komai), and south to the Loyalty Islands (Borradaile). Between these points there are records from the Java Sea (de Man, Odhner); in the Molucca Passage at Ternate (de Man) and at Siau and Salibabu Islands (Hansen); at Mindoro, Philippines (Kemp); New Britain and Rotuma (Borradaile); Gilbert Islands (Odhner); and Fiji (Brooks, Odhner).

Size.— The four males in the collection vary from 20.5 to 22.5 mm. in length, and the seven females, from 19.8 to 28.7.

Gonodactylus guerinii White

Gonodactylus guerinii White, Proc. Zoöl. Soc. Lond., 1861, p. 43, pl. 7; and Ann. and Mag. Nat. Hist. (3), **7**, p. 480.

Gonodactylus guerinii Miers, Ann. and Mag. Nat. Hist. (5), 1880, **5**, p. 121.

Protosquilla guerinii Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatop., pp. 75–78, pl. 16, figs. 1, 6.

Gonodactylus guerini Kemp, Mem. Indian Mus., 1913, **4**, pp. 192–93.

Gonodactylus (*Protosquilla*) *guerinii* Bouvier, Comptes Rend. Acad. Sci., 1914, **159**, p. 698.

Gonodactylus (*Protosquilla*) *guerini* Bouvier, Bull. Sci. de la France et de la Belgique, 1915, **48**, p. 313, pl. 7, fig. 10.

Gonodactylus (*Protosquilla*) *guerini* Carrić, Bull. Mus. National d'Hist. Nat., 1915, **21**, p. 151.

Gonodactylus guerinii Edmondson, Occ. Papers, B. P. Bishop Mus., 1921, **7**, pp. 299–300, fig. 1*g*.

Gonodactylus guerinii Gravier, Bull. Mus. Nat. d'Hist. Nat., 1928, **34**, pp. 337–340, figs. 1–3.

Diagnosis.— A Gonodactylus of Group III (Kemp) having eyes with compressed transverse cornea; dorsal process of ophthalmic somite erect, with obtuse angles in line with axis of eye; mandibular palp present; dactylus of raptorial limb evenly dilated at base, distally slender and curved, rostrum sharply trispinus, the median spine reaching half the length of the eyes; carapace flattened, its posterior width equal to its length, narrower anteriorly, antero- and postero-lateral angles rounded; first to fifth abdominal somites with L-shaped marginal carinae, fifth abdominal somite with anterior half nearly smooth, posterior half armed with small vertical spines arranged in 3–5 transverse rows parallel with the concave posterior margin, also two rows of similar spines on articular membrane; sixth abdominal somite and

telson fused into one piece armed with tall, slender, vertical, and outward slanting spines with soft tips, the central ones arising from three inconspicuous tubercles in the central area of the telson; anterior margin of telson defined by distinct grooves on dorsal and ventral sides, at posterior end four marginal teeth fringed with spines and separated by three deep fissures, the depth of the median fissure being more than half the total length of the telson; basal segment of uropod and endopodite, each with a longitudinal row of fixed spines on dorsal surface; basal process strongly convex laterally, its stout outer spine twice the length of the slender inner one, and reaching nearly to or beyond the tip of the exopodite, distal segment of the exopodite less than half the length of the proximal segment which is armed with eight or nine stout movable spines.

General Description.— It is remarkable that the only known examples of this beautiful species were found in such widely separated localities as Fiji, the Hawaiian Islands, Mauritius, and the Marquesas Archipelago. Although widely distributed, the species is rare in collections. Perhaps this rarity may be explained by its habits. The only information as to its habits that we have is furnished by a note addressed by M. Paul Carrié (1915) to the Musée Nationale d'Histoire Naturelle. He quotes a note of M. Thirioux, who discovered the species in Mauritius and furnished the specimen that was described by Bouvier (1915). M. Thirioux says of this species, known to him for twenty years, that it is found living among the corals at a depth of five to ten feet. When it wishes to rest or to flee from danger, it enters a cavity in the coral, which it has chosen, and blocks the entrance with the spiny shield on the terminal segments of the abdomen, "ce qui fait que le naturaliste croit avoir devant lui un petit ursin et ne pousse pas plus loin ses investigations." M. Carrié does not know the color, but suggests that probably it is the same as that of a little greenish sea-urchin, *Echinometra lucuntur* L., that is very abundant on the corals and strikingly resembles this part of the animal.

The terminal shield, consisting of the fused sixth abdominal somite and telson reinforced by the stout uropods, is indeed the most striking feature of the animal, and at once distinguishes the species from all others. It is well illustrated by Brooks (1886), and Bouvier (1915) gives an excellent photograph of it. In the hand, it suggests a composite flower, rather than a sea urchin.

Gravier (1928) criticises the drawing of Brooks (pl. 16, fig. 1) as imperfect. It shows, however, the arrangement of the spines as seen in our specimens, and corresponds in all essentials to the photograph given

by Bouvier (pl. 7, fig. 10). Gravier states that in his specimens the spines are longer and more thickly set than shown by Brooks, and his Figure 1 does give a better idea of the size and form of the spines. The photograph from which the drawing was made, however, was taken at an angle that does not give a view of their arrangement. From a study of the soft tips of the spines when stained and cleared, Gravier concludes that they are cuticular in structure and each is penetrated by a minute canal that opens at the apex. He found also, on the posterior part of the telson, some spines with bifurcated tips.

In our specimens the spines with soft tips are arranged on the dorsal surface in two series. The outer series consists of a double row shaped like a horseshoe. Beginning in the middle of the sixth abdominal somite it extends on each side to and along the lateral margin of the telson to the tips of the converging outer pair of marginal teeth. The space covering the articulation of the uropod between this double row of spines and the antero-lateral angles is densely covered by small spines. The central area is approximately circular in outline, and is occupied by twenty-two tall, straight, slender spines, evenly spaced and symmetrically arranged in two concentric circles around a central pair. They are nearly vertical with an outward obliquity proportionate to the distance in any direction from the center. Upon examination with a binocular microscope, it may be seen that these spines arise from three prominences that are slightly elevated, but are separated by distinct grooves. The median elevation is ovate or kite-shaped in outline with its short axis near the anterior end, the other two are nearly elliptical with their long axes convergent posteriorly, suggesting comparison with *G. glyptocercus*. At each end of the median elevation there is a median spine, and between there are three pairs, the spines of the anterior pair being the most widely separated from each other, and with the anterior median spine forming part of the outer circle. Each of the submedian elevations bears two spines of the inner circle and five of the outer circle, the posterior spine on each one being in line with the axis of the adjoining submedian marginal tooth. The line separating the telson from the sixth abdominal somite is marked by a sharp groove bordered by rounded folds, and it curves anteriorly around the outer circle of central spines. The three posterior marginal fissures of the telson are fringed with a single series of horizontal spines, their acute points being directed obliquely backward, and interlacing with their fellows of the opposite side.

Between the tergites of the fifth and sixth abdominal somites the articular membrane is thrown into two transverse inward folds. The

outward fold between them bears two rows of small spinules. In our largest specimen the body is bent at this joint so that the terminal shield, as seen from one side, makes an angle of about 108° with the abdomen, and the somites seem to be firmly fixed in this position. Brooks states that in the Challenger specimen the fifth and sixth abdominal somites are fused, but in our two smaller specimens the joint between these somites is perfectly flexible. On the posterior half of the fifth abdominal tergite is a semilunar area covered with small erect spinules arranged in three or five rows parallel to the posterior margin. The spinules of the anterior row incline forward, and those in the posterior row in the opposite direction. The anterior half is not entirely smooth, neither is it separated from the spinous portion by a distinct groove. The surface is symmetrically uneven with very irregular shallow depressions. On each side near the hinge there is a slight elevation divided unequally by a longitudinal groove, and between this elevation and the smooth marginal carina there is a short longitudinal carina bearing spinules.

The uropods are robust, protecting the delicate marginal spines of the telson. On the dorsal surface of the basal segment are two or three erect spinules, and the spine over the articulation is unusually stout and blunt. The basal prolongation is broad and blade-like, outwardly convex, curved, and twisted downward, so that its two spines lie nearly in a vertical plane, and give firm support to the exopodite. When folded inward, this part of the limb fits snugly upon the upper or outer surface of the process, the row of eight or nine stout movable spines pointing downward along its outer edge, and the tip of the distal segment extending nearly to or slightly beyond its outer spine. The articulation of the distal segment of the exopodite is terminal on the proximal segment, and has a small fixed spine on the ventral side. On the dorsal surface of the endopodite there is a longitudinal row of four or five generally sharp spinules. The fringe of marginal setae is complete on all the segments.

This species has a number of other peculiar features. The corneal portion of the eyes is compressed so that the long axis of the cornea, which is directed obliquely in a ventro-lateral direction, is twice the length of the shorter axis and about two-thirds as long as the peduncular axis. The propodus of the raptorial limb is finely serrate on the outer edge of the groove, and the dactylus is also finely serrate. In our smaller specimens the rostrum covers the ophthalmic somite as in Brooks's figure. In the larger specimen, on the other hand, the dorsal processes of this somite are easily seen in the angles between the median

and lateral spines. Their erect points can touch the margin of the base of the eye-stalk over the middle of the articulation. The scale at the antero-lateral angles of the first abdominal somite is unusually small. The dorsal surface of the carapace, exposed thoracic, and first four abdominal somites are without features of special interest. Edmondson (1921) has figured the endopodite of the first abdominal limb of the only known male.

Color.— There is no record of observations of the color of the living animal. Our largest specimen, when received for examination, was preserved in formaldehyde and presented the most striking appearance. The telson and sixth abdominal somite were whitish with their spines tipped with crimson. All the rest of the dorsal surface, the raptorial limbs, the tips of the thoracic appendages, and the uropods were bright crimson punctate with fine white dots. There were some dark markings on the telson and on the sides of the abdomen. The appendages of the first five abdominal somites were white. Soon after the specimen had been transferred to alcohol for better preservation, all the color faded away. One of our smaller specimens in alcohol has scattered stellate black pigment cells upon the dorsal surface from the eyes to the fifth abdominal somite, on the ventral side of the telson, and on the merus of the raptorial claw. On the carapace these are arranged in two transverse bands, one at each end; and on the exposed thoracic and abdominal somites there is a single broad transverse band on each tergite.

Distribution.— During the U. S. F. C. Hawaiian Explorations of 1902 the "Albatross" took in the tangles one specimen at each of the following stations: 4,159 and 4,161, both in the vicinity of Modu Manu, or Bird Islands, depth 30–31 fms. and 39–183 fms., bottom coral and sand; and station 3,845 on the south coast of Molokai, depth 60–64 fms., bottom sand and pebbles. All are females, total lengths 59.7 mm., *ca.* 24.3 mm., and 23.2 mm., respectively.

When I had the great privilege of examining the collection in 1910, there were five specimens in the British Museum (Natural History) the type, a female [1] from Fiji (White, 1861 and Miers, 1880); the "Challenger" specimen, a female from Honolulu (Brooks, 1886), and three females from Mauritius, the largest measuring 75 mm. from the tip of the rostrum to the end of the marginal teeth of the telson.

Since then, four other specimens have been recorded — a female 60 mm. in length in the Muséum National d'Histoire Naturelle (Paris)

[1] Brooks's reference to this as a male is evidently a slip of the pen: Miers describes it correctly as a female.

from Mauritius (Bouvier, 1915); a male (40 mm.) in the Bishop Museum dredged at Waikiki, Honolulu in 50 fms. (Edmondson, 1921); and two specimens in the Zoölogical Laboratory of the Paris Museum, a female 75 mm., from the coral reef on the south coast of Nouka Hiva Island in the Marquesas Archipelago, and a male, 32 mm., locality unknown (Gravier, 1928).

This species evidently has a wide geographical range, from Mauritius in the Indian Ocean on the west, to Hawaii and the Marquesas Islands on the east. Its habitat is among corals or on a sandy bottom at a depth ranging from a few feet (Carriè, Gravier) to at least 60 fathoms.

ODONTODACTYLUS Bigelow

Odontodactylus Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 445 (*ubi syn*).
Odontodactylus Kemp, Mem. Indian Mus., 1913, **4**, p. 133.

Diagnosis.— Stomatopoda with a compact, generally convex and compressed hind body, without dorsal carinae on the first four abdominal somites. Carapace not greatly narrowed anteriorly, without carinae; gastric grooves distinct; cervical groove entirely absent. Ischio-meral articulation of raptorial claw situated at a point in advance of the proximal end of the merus; propodus not pectinate; dactylus inflated at the base and armed with two or more teeth on the inner margin. Shorter ramae of last three thoracic appendages linear and composed of two segments. Telson with sharp median carina and one or more carinae on either side; strong submedian, intermediate and lateral teeth on distal margin, the first with movable spines. Ventral process of uropods terminating in two sharp spines, of which the inner is usually the shorter.

Remarks.— The genus *Odontodactylus* is a compact group of ten known species, all found in the Indo-Pacific region except *O. havanensis* in the West Indies. They are much alike in most of their characteristics, and are closely related to Group I of the genus *Gonodactylus*, from which they differ chiefly in the structure of the raptorial claw.

Type Species.— *Odontodactylus scyllarus* (Linnaeus).

Species Represented in the Collection.— *O. japonicus; O. hanseni.*

Odontodactylus japonicus (De Haan) [1]

Gonodactylus japonicus De Haan, in Siebold's Fauna Japonica, Crust., atlas, 1844, (?) pl. 51, fig. 7.

Gonodactylus edwardsii Berthold, Abh. k. Ges. Wiss. Göttingen, 1845, **3**, p. 30, pl. 3, fig. 6.

Odontodactylus japonicus Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 496.

Odontodactylus japonicus Kemp, Mem. Indian Mus., 1913, **4**, p. 139, (*ubi syn*).

Odontodactylus japonicus Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, **1**, p. 10.

Odontodactylus japonicus Komai, Annot. Zoöl. Japon., 1922, **10**, pp. 101–107, fig. 1–2.

Odontodactylus japonicus Parisi, Atti Soc. Ital. Sci. Nat, 1922, **61**, pp. 110–111, fig. 5.

Odontodactylus japonicus Komai, Mem. Col. Sci. Kyoto Imp. Univ. (B), 1927, **3**, pp. 336–338, pl. 13, fig. 3 and 4.

Diagnosis.— An *Odontodactylus* with subglobular eyes, the greatest diameter of the cornea being about one-fourth the length of the carapace, eye-stalks short; dorsal processes of the ophthalmic somite erect, wing-like, fused anteriorly at an angle, so that their crests are parallel to the sides of the rostrum; raptorial dactylus slightly dilated at the base and armed with five to seven teeth on its inner margin; mandibular palp composed of three segments; antennal scale large, nearly or quite as long as the carapace; rostrum subtriangular about one and a half times as broad as long, with its pointed apex strongly deflexed; carapace smooth with well marked gastric grooves, rounded angles, posterior margin concave, greatest breadth equal to length; fourth thoracic somite exposed, lateral margins of sixth and seventh rounded; first to fifth abdominal somites deep with vertical sides bordered by L-shaped marginal carinae, dorsally smooth, a distinct indentation on either side midway between lateral margin and median line of all but the first; sixth abdominal somite with four carinae and a large tubercle on either side, the lateral, outer intermediate, and submedian carinae ending in spines; median carinae obsolete; telson with median carina, not high, mucronate at posterior end, inner submedian carinae conspicuous, outer less prominent and continuous with one another around the posterior end of the median carina; intermediate carinae continued with a slight interruption to the apeces of the submedian marginal teeth; first lateral carina obscure and sinuous in anterior half,

[1] For the sake of uniformity, I am following Stebbing (1908, p. 45) and Kemp (1913, footnote p. 66) in accepting the claim of De Haan (1849), that his plate with named figures was published before Berthold's (1845) paper.

posteriorly continuous with a distinct carina on each intermediate tooth, second lateral prominent and joined to the marginal carina at the apex of the lateral marginal teeth; submedian marginal teeth minutely serrate on inner margin, two denticles between submarginal and intermediate teeth, and one between intermediates and laterals; ventral process of uropod with two broad teeth, the outer about twice the length of the inner, and each with a strong flat ridge on its lower surface; proximal segment of uropod with eleven to thirteen very long, broad, and flattened movable spines, the distal one paddle-shaped and reaching almost to or beyond the end of the distal segment.

General Description.— Of this species Kemp (1913) has given an excellent description, from which the diagnosis above has been quoted, with some modifications. Our specimens differ from his in some minor features, and a few particulars may be added.

Our collection contains only one fully developed specimen, a male 115 mm. in length on the median line (Pl. 1, Fig. 1). In this one the eyes are unusually large in proportion to the length of the carapace, the maximum diameter being one-fourth the carapace length. (In the British Museum specimens the ratio is about 1:4.5). The very characteristic dorsal processes of the ophthalmic somite are fused at an angle like the mouth of a jug, and the rostrum fits neatly over the space behind like a lid. The carapace is a little longer than its greatest width at the posterior angles, and is much narrower anteriorly. The exposed thoracic and abdominal somites are robust. When viewed from above their sides form nearly a straight line. The postero-lateral angles of the fourth and fifth abdominal somites end in small spines. On the sixth abdominal somite the submedian, second intermediate, and lateral carinae have terminal spines. The tubercles on the anterior margin of the telson are inconspicuous. Of the uropods, the basal segment of the exopodite is close to twice the length of the distal segment, and the number of movable spines on the former is eleven. In this collection there is no mature female, but in the British Museum (Natural History) I had the privilege of comparing two males (139 and 164 mm.) with a large female (131 mm.) and found no secondary sexual differences.

Color.— The brilliant coloring of living specimens of this species has been described by Komai (1922; 1927, pl. 15, figs. 3–4). It is remarkable for its striking sexual dimorphism. In males, the whole dorsal surface of the body is bright salmon-red, shading into vivid purple on the antennal scales and uropods, while the marginal hairs of these appendages are very bright scarlet, and the mobile spines on the exopodites of the uropods are orange. In females, the posterior half

of the body is bluish green, shading into the salmon-red of the anterior half at the first abdominal somite.

Komai found one exceptional male with the female coloring, and upon dissecting it discovered that the testes were abnormal.

Distribution.— All the specimens in the collection were taken in the waters of Hawaii during April and July, 1902 — an immature female(?) 30.6 mm. in length, with *Gonodactylus guerinii* at station 3,845 on the south coast of Molokai in 60–64 fathoms, an immature male 33.5 mm. long at station 4,062 on the northeast coast of Hawaii Island, 83–113 fms., and one male 115 mm. long on the north coast of Maui in 95–152 fms.

The type locality for this species is Japan (De Haan), and it has been reported from that region by Balss, Kemp, Parisi, and by Komai, who says that it inhabits the warmer parts of the Japanese coast in the range of the "Black Stream," and is rather common. Other localities reported are — Chinese seas (Berthold, Miers), Hongkong(Kemp), Korea and the Bonin Islands (Komai), Saya de Malha Bank, southeast of the Seychelles (Borradaile), and Broome, Australia (Alexander). The specimens that I examined in the British Museum were from Swatow, China.

Odontodactylus hansenii (Pocock)

Gonodactylus hansenii Pocock, Ann. Mag. Nat. Hist. (6), 1893, **11**, p. 477, pl. 20, fig. 3, 36.

Odontodactylus hansenii Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 496.

Odontodactylus latirostris Borradaile, Trans. Linn. Soc., Zoöl., (2), 1907, **12**, p. 212, pl. 22, figs. 3, 3*a*.

Odontodactylus hanseni Kemp, Mem. Indian Mus., 1913, **4**, p. 140.

Odontodactylus latirostris Kemp, *ibid.*, 1913, p. 141.

Odontodactylus hansenii Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, p. 297, fig. 1, *e* and *f*.

Odontodactylus hansenii Hansen, Siboga-Exped., Monogr., 1926, **35**, pp. 23–24, 44–46.

Diagnosis.— An *Odontodactylus* with large subglobular eyes, the diameter of the cornea varying from 2.5 to nearly 4 in the median length of the carapace; ophthalmic somite exposed, and the dorsal process deeply excavate anteriorly; antennal scale little shorter than the carapace, proportionally smaller in young individuals; mandibular palp of three segments; raptorial dactylus dilated at the base and armed with six to eleven marginal teeth, not including the terminal spine, which is slender with a marked reverse curve; rostrum broader

than long, evenly rounded or truncate triangular; carapace nearly as broad as long, angles rounded, anterior border transverse, posterior slightly concave; fourth thoracic tergite not exposed, margin of fifth not produced, of sixth and seventh rounded; first to fifth abdominal tergites of nearly uniform width, smooth except for a groove, deeper posteriorly, on the side of each somite, except the first, about one third the distance from the lateral margin to the median line; lateral margins slightly thickened, ending in a spine on the fourth and fifth somites; sixth abdominal tergite with a pair of elongated tubercles and four pairs of carinae, three of them ending in spines, no median carina; telson wider than median length, median crest high and narrower with a short terminal spine and a distinct notch near the anterior end, a single pair of narrow submedian, intermediate, second lateral and marginal carinae (no first lateral carina), the second lateral carina running parallel to the margin except at the posterior end, where it may bend sharply toward the apex of the lateral tooth; three pairs of strong marginal teeth, the submedian pair finely serrate on inner margin and ending in a well developed mobile spine, two denticles between sub-median and intermediate teeth, and one between the intermediate and the lateral; on the dorsal surface of the uropods a deep longitudinal groove bordered by sharp ridges along the endopodite and the proximal segment of the exopodite; on the ventral surface of the basal process a sharp ridge extending to the tip of the inner spine, which is shorter than the outer one; movable spines on the exopodite ten to twelve, acute, the distal one curved toward the apex of the broadly ovate distal segment, length variable.

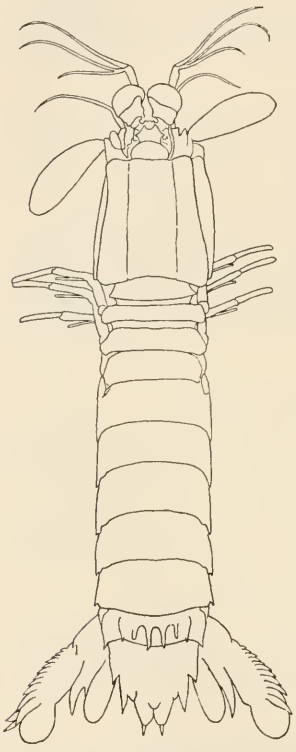

Fig. 2.— *Odontodactylus hansenii* (Pocock), male, 56.0 mm. (No. 24). The color pattern and details of the telson are not shown.

General Description.— The collection contains seven specimens taken at six stations in Hawaiian waters during the explorations of 1902.

Comparison of these specimens with the type of *O. hansensii* Pocock in the British Museum and with the type of *O. latirostris* Borradaile at Cambridge enables me to confirm the supposition of Kemp (1913) and of Hansen (1926) that the two species are identical. The chief difference between the two types is in the number of teeth on the raptorial dactylus, nine in addition to the terminal spine in *O. hansenii* and seven in both specimens of *O. latirostris;* but these numbers are within the range of variation shown by the present collection. There is also a slight difference in the rostrum — evenly rounded in the type, truncate triangular in *O. latirostris.*

Kemp (1911, 1913) has described as *Odontodactylus southwelli* a very similar form "that may be distinguished from them at a glance by the enormous size of the eyes." It is undoubtedly this form that was taken by the "Siboga" Expedition, but Hansen (1926) supposes this to be identical with *O. hansenii.* Hansen is perfectly correct in saying that full size of the eyes is not seen in dorsal view. In preserved specimens the longest diameter of the cornea is nearly vertical, but in all the specimens that I have measured, including the type of *O. latirostris,* there is none in which this diameter is contained less than 2.5 times in the median length of the carapace. Kemp gives the size as 2.25 in the carapace, the proportion remaining approximately constant in five specimens between 21 and 37 mm. in total length, while Hansen gives the proportion in the five "Siboga" specimens as ranging from 1:2 to 1:2.66, the total length being from 16 to 62 mm. In six specimens of our collection, 28.5 to 80.6 mm. long, the proportion of maximal corneal diameter to carapace varies from 1:2.5 to 1:3.9, and the types of Pocock and of Borradaile fall within this range. Unfortunately, while verifying Pocock's description by comparison with the type, I did not repeat his measurements; but I have no doubt that they are correct. Hansen says that in the "Siboga" specimens the eyes are proportionally smallest in the largest specimen and largest in the smallest specimen. My results when arranged in order of size are too irregular to permit of any generalization. Kemp records a male of *O. southwelli ca.* 28 mm. long. The two smallest specimens in our collection are of about the same size. I am unable to determine their sex, but they may be females.

A peculiar feature of our largest specimen is a distinct spinule on the dorsal surface of the ophthamic somite, just behind each dorsal process. Another specimen shows traces of these spinules.

Another specimen (26♂) has the surface of the telson distinctly pitted on both sides of the intermediate carinae, with somewhat less distinct pits on the ventral surface.

O. hansenii may be distinguished at a glance from *O. japonicus* by differences in the sculpturing of the telson. In the former there is on each side a single submedian carina, the intermediate is not continuous with the dorsal crest of the submedian tooth, the first lateral is represented only by the dorsal crest of the intermediate tooth, and the second lateral does not run a straight course toward the tip of the lateral tooth but is mainly parallel to the lateral margin.

Our series furnishes an interesting comparison of the proportions of the parts at various stages of development, from juvenal specimens of indeterminate sex about 28 mm. long to a fully developed female 80 mm. long. In the large specimen the raptorial dactylus is strongly dilated toward the base, while in all the smaller ones it is moderately dilated, as described by Kemp. In the large specimen the posterior end of the lateral carina of the telson follows the inner margin of the lateral tooth to its tip, and unites there with the marginal carina, as figured by Edmondson (1921, fig. 1*f*). In younger individuals it terminates before reaching the tip of the tooth, as described by Kemp. The last movable spine of the uropod in the large specimen is three-quarters the length of the terminal segment; in the juvenals it reaches the tip of the segment, and is intermediate in length in the others. Likewise, the outer spine of the basal process in the largest female does not reach to the end of the endopodite, while in all the others it extends that far or farther. Our youngest specimens show some of the characteristics of Hansen's later postlarval stage (Hansen, 1926, pp. 44–46).

Color.— The only information that we have of the color of living specimens is a note on the label of the two males from station 3,845, "Last segment of telson pink, eyes apple green, dorsum rusty, mottled." In alcohol these and several other specimens have the eyes brown, streaked horizontally with black, and on the proximal segment of the exopodite is a dense black patch, on both dorsal and ventral sides and extending on to the corresponding part of the basal process. This marking is very characteristic of the species, but in the large female and a smaller male the black pigment is chiefly on the basal segment, extending partly over the proximal segment of the exopodite.

Distribution.— The stations and depths at which this species was taken by the "Albatross" are:—3,845, south coast of Molokai, 60–64 fms.; 3,861, Pailolo Channel between Molokai and Maui, 30–52 fms.; 3,982, off Kauai, 233–240 fms.; 4,031 and 4,034, Penguin Bank, south coast of Oahu, 27–28 and 24–83 fms.; 4,061, northeast coast of Hawaii Island, 24–83 fms. Edmundson (1921) reports three specimens in the Bishop Museum from off Waikiki, Honolulu, 30–50 fms.; and Hansen (1926) reports a specimen in the Copenhagen Museum from Hawaii.

The type (Pocock, 1893) is from Macclesfield Bank, South China Seas, 35 fms.; and Borradaile's specimens are from the Amirante Islands, 25–30 fms. Other localities recorded are Yoko (=Sulu) and Amboina Bay (Hansen). The "Siboga" specimens were taken at North Ubian in the Sulu Sea, at two stations off the northwest of New Guinea and at Benda (south of the Moluccas). Kemp's specimens of *O. southwelli* are from several localities in the Andaman Islands and from N. Cheval Parr, Ceylon. The distribution so far recorded includes the Hawaiian Islands, the East Indian Archipelago, and the Indian Ocean.

List of Specimens

No.	Sex	Length	Station
23	♀	80.6 mm.	4031
24	♂	56.0	3982
25*a*	♂	52.0	3845
25*b*	♂	40.9	3845
26	♂	33.0	4061
27	juv.	28.5	4034
28	juv.	27.4	3861

PSEUDOSQUILLA Dana

Squilla, squilles trapues H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, pp. 518, 525.

Gonodactylus H. Milne-Edwards, *ibid.*, 1837, pp. 528, 530 (*partim*).

Squilla sect. *parallelae* De Haan, in Siebold's Fauna Japonica, Crust., 1849, p. 221.

Pseudosquilla (Guerin *ined.*) Dana, U. S. Explor. Exped., Crust., 1852, p. 621.

Pseudosquilla Miers, Ann. Mag. Nat. Hist. (5), 1880, **5**, p. 108.

Pseudosquilla Brooks, Voy. H. M. S. "Challenger," 1886, **16**, p. 53.

Pseudosquilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 498.

Pseudosquilla Kemp, Mem. Indian Mus., 1913, **4**, p. 94.

Diagnosis.— Stomatopoda with hind body generally very convex and smooth, without sharp carinae, except on the last two somites; mandibular palp composed of three segments; dactylus of raptorial claw not inflated and armed with teeth, of which there are not more than four including the terminal one; upper margin of propodus finely pectinate externally, merus articulating terminally with the ischium, and its ventral surface channeled throughout its length; shorter ramus of the last three thoracic limbs linear; telson with a median crest and

one to five pairs of additional carinae; submedian, intermediate, and lateral marginal teeth well formed, the first with movable tips; no submedian denticles and never more than three intermediate ones.

Remarks.— The diagnosis, quoted in part from Kemp (1913), is intended to exclude *P. stylifera* (H. Milne-Edwards), for which Hansen suggested without description (1895) a new genus, *Hemisquilla*. This has been accepted by Kemp and Chopra (1921) because of the outstanding peculiarities of the species in question. Kemp states that the species of *Pseudosquilla* are invariably found in shallow water, and seem to prefer rough ground, coral reefs, oyster beds, and similar situations. They are distributed throughout the warmer waters of both hemispheres.

Type Species.— *Pseudosquilla lessonii* (Guerin).

Species Represented in the Collection.— *P. ciliata* (Fabricius); *P. ornata* Miers; *P. oculata* (Brullé).

Pseudosquilla ciliata (Fabricius)

Squilla ciliata Fabricius, Mantiss. Insect., 1787, **1**, p. 333.
Cancer ciliatus Linnaeus, Syst. Nat., ed. 13, 1790, **1**, p. 2990.
Squilla ciliata Fabricius, Ent. Syst., 1793, **2**, p. 512.
Squilla stylifera Lamarck, Hist. Nat. Anim. Sans Vert., 1818, **5**, p. 189.
Squilla quadrispinosa Eydoux and Souleyet, Voy. de la "Bonite," Zoöl., 1841, **1**, Crust., p. 262, pl. 5, fig. 1.
Pseudosquilla stylifera Dana, U. S. Expl. Exped., Crust., 1852, **1**, p. 622, pl. 41, figs. 4*a–e*.
Pseudosquilla ciliata Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, pp. 108, 458, pl. 3, figs. 7, 8.
Pseudosquilla ciliata Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatop., p. 53, pl. 15, fig. 10.
Pseudosquilla ciliata Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 499.
Pseudosquilla ciliata Bigelow, Bull. U. S. Fish Comm., 1902, **20**, pt. 2, p. 154, figs. 3, 4.
Pseudosquilla ciliata Balss, Abh. Math.-Phys. Kl. K. Bayer. Akad. Wiss., 1910, Suppl., Bd. 2, Abh. 2, p. 6.
Pseudosquilla ciliata Balss, Denk. Math. Nat. Kl. K. Akad. Wiss. Wien., 1910 (1912), preprint of **87**, Fortsetzung B., p. 32.
Pseudosquilla ciliata Kemp, Mem. Indian Mus., 1913, **4**, pp. 96–100, 108, 196. (Includes complete bibliography to 1910.)
Pseudosquilla ciliata Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 311.
Pseudosquilla ciliata Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 172.
Pseudosquilla ciliata Sunier, Inst. Sci. Buitenzorg, Contr. Faune Indes Neérl., 1918, **1**, (4), p. 72.

Pseudosquilla ciliata Rathbun, Netherlands Kolonien Min. Rapp. Betref. Visscherij Curaçao, 1919, **2**, p. 347.

Pseudosquilla ciliata Tattersall, Jour. Linn. Soc. Zoöl., 1921, **34**, p. 357.

Pseudosquilla ciliata Edmondson, Occ. Papers B. P. Bishop Mus., 1921, **7**, pp. 288–290.

Pseudosquilla ciliata Parisi, Atti Soc. Ital. Nat., 1922, **61**, p. 103.

Pseudosquilla ciliata Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, (4), p. 6.

Pseudosquilla ciliata var. *occidentalis* Verrill, Trans. Conn. Acad. Arts and Sci., 1923, **26**, pp. 192–193, pl. 50, fig. 1, 2; pl. 51, fig. 1, 1*b*; pl. 54, fig. 2.

Pseudosquilla ciliata Schmitt, Bijdr. Dierk., Amsterdam, 1924, **23**, p. 81.

Pseudosquilla ciliata Edmondson, B. P. Bishop Mus. Bul., 1925, No. 27, p. 59.

Pseudosquilla ciliata Hansen, Siboga-Exped. Monogr., 1926, **35**, (Livr. 104), pp. 17–18.

Pseudosquilla ciliata Komai, Mem. Col. Sci., Kyoto Imp. Univ., (B), 1927, **3**, pp. 323–324.

Diagnosis.— A *Pseudosquilla* with cylindrical eyes; the dactylus of the raptorial claw slender, with three elongated teeth, including the terminal one, and the propodus bearing three movable spines at the base of its pectinate margin; rostrum wider than long, widest in front of the base; lateral margins strongly rounded and meeting apically in a very obtuse angle; carapace considerably longer than wide, without carinae or cervical groove, gastric grooves converging anteriorly, and antero-lateral angles rounded; four thoracic somites exposed, smoothly arched dorsally, the fifth with a deep vertical groove on its lateral face, lateral margins slightly produced, the fifth acute, the others more or less rounded, the eighth with a small and deeply incised apical notch; the first five abdominal somites strongly arched and smooth, except for a Y-shaped groove on the lateral face of the first and a pair of pits on each of the four succeeding somites; postero-lateral angles of the first three rounded, of the fourth rounded or ending in a small spine, of the fifth invariably spinous; sixth abdominal somite with six strong spines, the intermediate pair arising farther forward than the others, about halfway between the anterior and posterior margins; the telson with a high narrow crest ending in a spine, and six other carinae, one pair on the lateral margins and two pairs grouped near the crest, the submedian pair being low; six large marginal spines, the submedian pair long and mobile; the basal process of the uropods long and ending in two slender spines, of which the inner one is the longer and reaches nearly to the apex of the exopod, seven to ten movable spines on the proximal segment of the exopod, the terminal one not extending beyond the apex of the ultimate segment, which is at least one-half the length of the proximal one, a single fixed spine on the ventral surface at the articulation between the two segments.

General Description.— This is the most abundant species in the collection, which contains three specimens from Samoa and seventy-eight, ranging in size from about 17.5 to 75.5 mm., from fourteen stations in the Hawaiian Islands.

The species has been very completely described by Kemp (1913). One feature that he does not mention is a distinct spine situated on the distal end of the propodus of the raptorial claw and directed toward the articulation of the dactylus (Bigelow, 1902, fig. 3).

In the "Challenger" collection there were two specimens from the West Indies and one from Honolulu. Brooks (1886) found that the

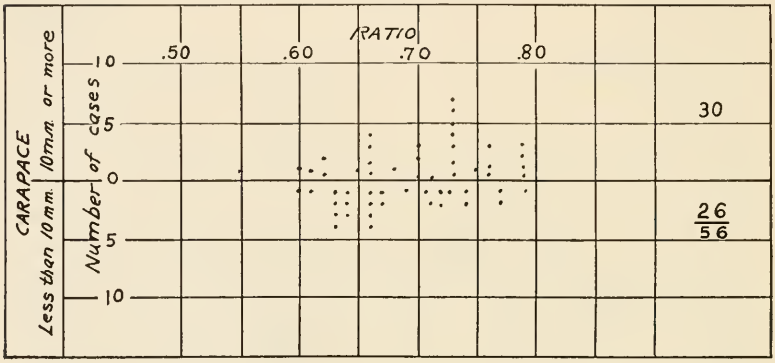

FIG. 3.— Ratio of length of distal segment of exopodite of uropod to that of proximal segment in 56 specimens of *P. ciliata*, 30 larger specimens (carapace length 10 mm. or more) compared above the zero line with 26 smaller ones below that line.

West Indian specimens differed from the one from Honolulu in three points: (1) the paddle of the uropod was a little shorter than the proximal segment of the exopodite, (2) the spines of the basal process of the uropod were equal in length, and (3) the postero-lateral angles of the fourth abdominal somite were produced into small but distinct spines. Borradaile (1900) proposed on these characters to separate the Atlantic from the Pacific form as var. *occidentalis*. But Tattersall (1906) had a specimen (33 mm.) from Ceylon which he compared with Brooks's specimens in the British Museum and found that "this specimen agrees with Brooks's West Indian examples in those points in which the latter differ from the Pacific ones."

Measurements of fifty-six specimens having a total length of 30 mm. or over in our collection show a wide range of variation in the ratio of the lengths of the two segments of the exopodite of the uropod. The

distal segment is always the shorter and varies from 0.55 to 0.79 of the length of the other. The ratios, when plotted (Fig. 3), show a tendency for the ratio to increase with the size.

In our collection the inner spine of the basal prolongation of the uropod is invariably longer than the outer one, and this has been found to be true also of West Indian specimens by Bigelow (1902) and by Verrill (1923).

The postero-lateral angles of the fourth abdominal somite in one of our Samoa specimens are distinctly produced as spines. In the other two they are not clearly spinous, but are more or less acute. The

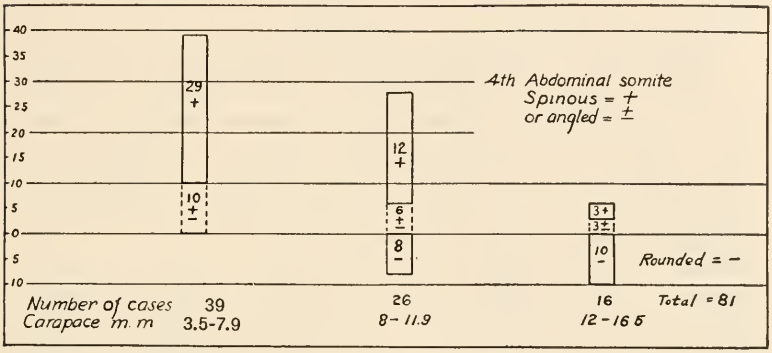

FIG. 4.— Diagram of 81 specimens of *P. ciliata* (3 from Samoa and 79 from the Hawaiian Islands) showing the number having the fourth abdominal somite spinous (+), angled (±), or rounded (−) at the postero-lateral angle; in three size-groups, small, medium, and large, — carapace lengths 3.5 to 7.9, 8 to 11.9, and 12 to 16.5 mm., respectively.

seventy-eight specimens from Hawaii vary from strongly spinous to decidedly rounded angles. These variations, when plotted against length of carapace (which, as pointed out by Kemp, can be measured more accurately than total length), clearly show (Fig. 4) a tendency for the spines to disappear with increase in the size of the animal.

The smallest specimen in the collection that has the characteristics of the adult form is a male 17.5 mm. long. It differs from the fully developed adult only in the absence of submedian carinae on the telson and in the incomplete development of the intromittant organs, which are 0.42 mm. long and reach only halfway from the base of the exopodite to the median line. The specimen shows traces of the characteristic pigmentation of the species.

In the report on the Porto Rico collection of the U. S. Fish Com-

mission (Bigelow, 1902, p. 156), mention is made of five similar specimens ranging in size from 16 mm. to 17.5 mm., and Kemp (1913, pp. 100 and 108) records two specimens in the Indian Museum, as small as 19 and 27 mm. in length, that possess all the adult characteristics.

These specimens, at the beginning of the adult stage, are of special interest because of the aid they furnish in the identification of the previous postlarval stage. As pointed out by Kemp (1913, p. 108), their existence does not necessarily prove that the *monodactyla* stage of the same size does not belong to this species. In fact, comparison of the two stages in the Porto Rico collection led to the opinion that, at the time of metamorphosis, growth results in a thickening of the body without an increase, or with a slight shrinkage in length; and Kemp has suggested independently the same thing.

Postlarval stage.— The larval stage of *P. ciliata* has been identified by Hansen (1895) and named *Pseuderichthus communis*. He distinguished it from the very similar larva of *P. oculata* Brullé by its smaller size and the possession of eight distinct spines on the uropod. This stage has been more fully described and figured by Jurich (1904, pp. 395–96, pl. 29, fig. 1). Among other distinctive characters, he mentions the slightly concave posterior margin of the telson, without median indentation, and bearing tertiary spinules.

Between the *pseuderichthus* stage and the first adult stage there is a transitional stage, first described by Claus (1871, figs. 26 and 27*c*). Hansen has found by comparison of the type specimens that the form described by A. Milne-Edwards (1878) as *Squilla monodactyla*, and by Miers (1880) as *Pseudosquilla monodactyla* is this stage in the life-cycle of *Pseudosquilla oculata* Brullé, and Hansen mentions two specimens in the Copenhagen Museum that are this stage of *P. ciliata*, having a length of 17.5 and 21.3 mm. The Porto Rico collection contained five specimens of *P. ciliata* in the *monodactyla* stage. These were briefly described (Bigelow, 1902, p. 156).

The present collection contains three specimens in this stage, all from the Hawaiian Islands, as follows: station 3,812, south coast of Oahu, March 27, 1902, 7.30 P.M., surface, 20.4 mm.; station 3,847 south, coast of Molokai, April 8, 1902, noon, 1♂ 18.0 mm.; station 3,921, off Honolulu, south coast of Oahu, May 6, 1902, 8.45 P.M., 17.5 mm.

Two of the specimens are in excellent condition and furnish material for a more detailed description of this interesting stage. They differ from the adult form chiefly in the more slender proportions of the body, in the shape of the eyes and of the raptorial dactylus, and in the presence of thirty-five to thirty-six minute denticles on the pos-

terior margin of the telson between the mobile submedian teeth (Fig. 5). These denticles, secondary spinules of Jurich, are of nearly uniform size. There is no indication of the tertiary spinules that Jurich finds to be characteristic of the *pseuderichthus* stage of this species. The dactylus of the raptorial limbs is without lateral teeth, but beneath the integument the rudiments of the two lateral teeth are more or less clearly visible. The propodus bears the usual three movable spines, and has a strong spine near the distal articulation (Fig. 6). In place of the usual pectinations on the upper edge, there is a

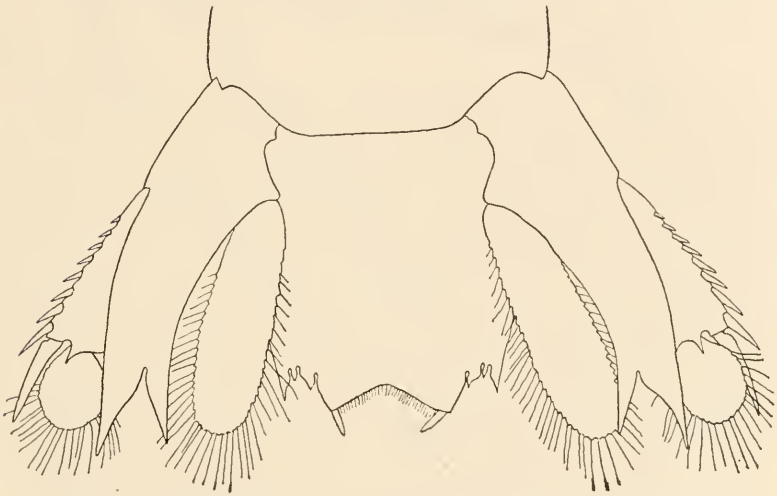

FIG. 5.— Telson and uropods of *P. ciliata* in the postlarval stage, ventral aspect.

series of fine hairs. The eyes are large and, unlike the adult form, are somewhat compressed laterally. They differ in shape from the eyes, at this stage, of both *P. ornata* and *P. oculata* in being elliptical in lateral view. The keel on the dorsal process of the basal segment of the antennae is *concave* in lateral view, as in the adult.

The rostrum is of the adult form, wider than long, the apex obtuse and depressed. The carapace is of the adult form but not so broad, its width being less than half its length. The postero-lateral angles of both the fourth and the fifth abdominal somites are strongly spinous. The sixth abdominal somite has the usual submedian and lateral marginal spines, but no trace of the intermediate pair. The telson is wider than long, smooth above, except for a low narrow median crest that ends

in a sharp spine at a *considerable distance* (0.16 to 0.23 mm.) from the posterior margin, which forms an obtuse reëntrant angle. The marginal teeth and denticles, except the submedian ones mentioned above, are of the adult form. The two spines of the basal process of the uropods are of nearly equal length, the *outer spines being slightly the longer*. The paddle of the exopod is about *half* the length of the proximal

Fig. 6.— Raptorial limb of *P. ciliata* in the postlarval stage.

segment, which in all three specimens bears *nine* movable spines. Both the basal process and the distal spine of the exopod are relatively longer than in the adult form.

The records of capture of specimens in the *monodactyla* stage indicate that at this period in the life-cycle, the animals inhabit the bottom during the day and swim near the surface at night.

Color.— George Clark (1869, *sub Squilla stylifera*) has observed that, "When first hatched the larvae are of a delicate yellowish green.

As they grow they assume a mottled grey, and the swimmerets and legs become pea-green." Preservation in alcohol destroys all traces of color, excepting the retinal pigment, in specimens of the *pseuderichthus* and *monodactyla* stages. The earliest adult stages show, however, traces of what appears to be a characteristic color pattern. This consists of groupings of black pigment cells that form a series of dark patches on each side of the body. There are three pairs of these patches on the carapace, and one pair on each of the other segments, including the telson. The extent to which this pattern is represented varies greatly in different individuals, the patches most frequently observed being those on the sixth thoracic and first abdominal somites (Edmondson, 1921) and on the telson. There may be only a single pair of patches, or none at all.

The color of living adults has been described by Clark (1869) and by Verrill (1923). It is interesting to note that in this species, which shows no structural sexual dimorphism, both Clark at Mauritius and Verrill at Bermuda observed sexual differences in color, the male being often bluish green with red markings on the appendages, while the female is often mottled with brown and gray, but also trimmed with red. In our collection I have noticed a black spot on the ventral surface of the sixth thoracic somite just behind the genital pores of all except the smallest females, and the entire absence of this spot in all males.

Distribution.— Among all known species of Stomatopoda there are only three or four that have been found both in the Atlantic and the Indo-Pacific region. *Pseudosquilla ciliata* is one of the most common of these, occurring in abundance in shallow water among corals and in similar situations, over a wide range (see Kemp, 1913, p. 100).

Our three specimens from Samoa are all from shore collections, and the same is true of a large proportion of the Hawaiian specimens. The greatest depths from which specimens were taken are at station 3,850, 43–66 fathoms, and station 4,055, 50–62 fathoms. One specimen was obtained from the Honolulu market, indicating that this species is an article of food.

Size.— Our specimens in the adult stage range in size from 17.5 to 75.5 mm. Kemp (1913) records a female from Samoa that is 81 mm. in length.

Table of Measurements

P. ciliata, postlarval form

Specimen no.	35*r*	58*a*	64
Sex	♂	♀ ?	?
Total length	18.0 mm.	20.4 mm.	17.5 mm.
Carapace length	3.67	3.84	4.17
Rostrum length	0.92	1.02	—
width	1.40	1.48	—
Eye width	1.00	1.04	—
length	1.80	1.83	—
height	1.20	1.33	—
Telson length	2.58	2.66	—
width	2.67	2.75	—
Tip of median spine to edge of telson	0.16	0.16	0.23
Uropod, exopodite distal seg.	0.80	0.88	0.72
prox. seg.	1.52	1.60	1.52
number of mobile spines	9	9	9

Pseudosquilla ornata Miers

Pseudosquilla oculata Heller, Verh. Zool.-Bot. Ges. Wien, 1861, **11**, p. 497 (*nec* Brullé, 1836–44).

Pseudosquilla ornata Miers, Ann. Mag. Nat. Hist. (5), 1880, **5**, p. 111, pl. 3, figs, 5. 6.

Pseudosquilla ornata, Kemp, Mem. Indian Mus., 1913, **4**, pp. 100–101.

Pseudosquilla ornata Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 311.

Pseudosquilla ornata Kemp, Philip. Jour. Sci. (D), 1915, **10**, p. 172.

Pseudosquilla ornata Parisi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 103.

Pseudosquilla ornata Komai, Mem. College of Sci. Kyoto Imp. Univ. (B), 1927, **3**, pp. 324–325, pl. 14, figs. 2–2*b*.

Diagnosis.— A *Pseudosquilla* having a narrow, strongly arched body, the greatest breadth of the abdomen about one-sixth the total length; eyes club-shaped, the cornea dorso-ventrally flattened and set transversely on the stalk; dorsal process of the basal segment of the antenna is deeply channeled dorsally, and the margin of its ventral keel is convex in lateral view; mandibular palp of three segments; dactylus of raptorial claw with two lateral teeth in addition to the terminal one, the edge of the propodus pectinate along about half its length and armed with three movable spines, a small depressed spine at the distal end of the segment, distal margin of the carpus produced ventrally into

a short spine; rostrum nearly twice as broad as long; seventh thoracic somite squarely truncate laterally, and the eighth obscurely incised; telson with a narrow median crest ending in a spine, and three pairs of carinae — submedian, intermediate, and lateral; the marginal teeth strongly developed, the intermediate pair reaching to the level of the bases of the movable spines of the submedian ones, and the denticles lobular in form; outer spine of the basal process of the uropods much longer than the inner spine, and reaching to the distal end of the exopod; on the proximal segment of the exopod nine to eleven movable spines, the distal one exceeding the length of the ultimate segment, which is less than half the length of the proximal segment.

General Description.— Of this species the collection contains a single adult specimen, a female 69 mm. in length, in excellent condition, from the coral reef at Apia in Samoa.

The body is slender and compact, with nearly straight sides, the greatest width of the carapace and of the abdomen being little more than one-seventh of the total length. The depth of the abdomen is about eight-tenths of its breadth. The eyes are somewhat club shaped, the corneal area being somewhat wider than the stalk, and the eyes are slightly flattened obliquely. The raptorial limb closely resembles that of *P. ciliata*, except in one feature. That is a distinct spine on the ventral (not "dorsal") edge of the carpus. In this it appears to differ from the specimens in the Indian Museum (Kemp, 1913, p. 101) and to agree with the specimens described by Komai (1927) and with Borradaile's *P. oxyrhyncha* (1898, pl. 6, fig. 9). Komai (1927) regards *P. oxyrhyncha* as a synonym of *P. ornata* because of this feature and because of variation that he found in the form of the rostrum, one of his two specimens having the apical spine characteristic of *P. oxyrhyncha* and the other being without it. In our specimen the apex of the rostrum is a very obtuse angle without trace of spine. Its sides are broadly rounded.

The carapace is very smooth, but with distinct gastric grooves. The angles are rounded, the anterior border nearly transverse, and the posterior margin evenly concave. The postero-lateral angles of the first to third abdominal somites are rounded, of the fourth rectangular, and of the fifth spinous. The sixth abdominal somite and the telson are like those of *P. ciliata*, except that the spines are a little stronger. The intermediate marginal teeth of the telson are, however, not so long as figured by Miers (1880, pl. 3, fig. 6). They extend only a little beyond the articulation of the movable submedian teeth, not to the tips. There is a deep fissure between the intermediate denticles, and the

ventral surface of the telson is considerably more concave than in *P. ciliata*. The uropods present several differences from *P. ciliata*. The endopod is narrowed posteriorly. The distal segment of the exopod is little more than one-third the length of the proximal segment, which bears a strong fixed spine at its distal end on the ventral side, and on the outer edge ten movable spines, the outermost one extending well beyond the apex of the distal segment. The inner spine of the basal process reaches the base of the distal segment, and the outer one terminates just at its tip. The inner margin of the basal process is smooth, except that there is a small blunt tooth near the base of the inner spine.

Color.— The only information available as to the color of this species in life is from the label with an immature specimen from the Philippines quoted by Kemp (1915, p. 172) as follows: "Red with brown tinge and with cream colored dots and cream colored bars transversely on carapace and on telson, extending on to the uropods." The specimen in alcohol shows also traces of eye-spots on the carapace. A pair of large eye-spots on the carapace appears to be the most striking characteristic of this species (Komai, 1927, pl. 14, fig. 2). On our specimen each of these spots consists of a central bluish black area circular in outline and about 3.5 mm. in diameter, surrounded by a narrow pale border. The gastric groove traverses the upper half of the spot. The ground color of our specimen in alcohol is a brownish purple. In front of the eye-spots the carapace is marked by a median and two lateral pale areas beset with numerous small round spots of the ground color with lighter centers. There are dark shadings on the sides of the abdominal somites, and the telson and uropods are dark with transverse pale bars. The walking legs and the propodus of the raptorial claw are orange, and the dactylus pink. The ventral surface of the thorax is marked by a dark patch near the base of each walking leg, as described by Komai.

Postlarval Stage.— In a container with a specimen of *Gonodactylus glabrous* from Apia was found a *Pseudosquilla* in the *monodactyla* stage. This appears to represent the postlarval form of *P. ornata*, not before described, so far as I know. The animal is a male, 20.5 mm. long on the median line. It is remarkable for the precocious development of the intromittent organs. Although the rudiments of the lateral teeth on the dactylus are hardly visible beneath the integument, the intromittent organs are as far advanced as in the first adult stage of *P. ciliata*, reaching halfway to the median line, whereas they are mere buds in the same stage of *P. ciliata*.

In addition to this peculiarity, the specimen may be distinguished from the *monodactyla* stage of *P. ciliata* at a glance by the shape of the

eyes and of the rostrum and the structure of the uropods. The eyes are *pyriform,* slightly flattened on their medial sides. The rostrum, a little wider than long, is *subtriangular,* with nearly straight sides, and the tip slightly depressed, but *not* furrowed. The width of the telson is *less*

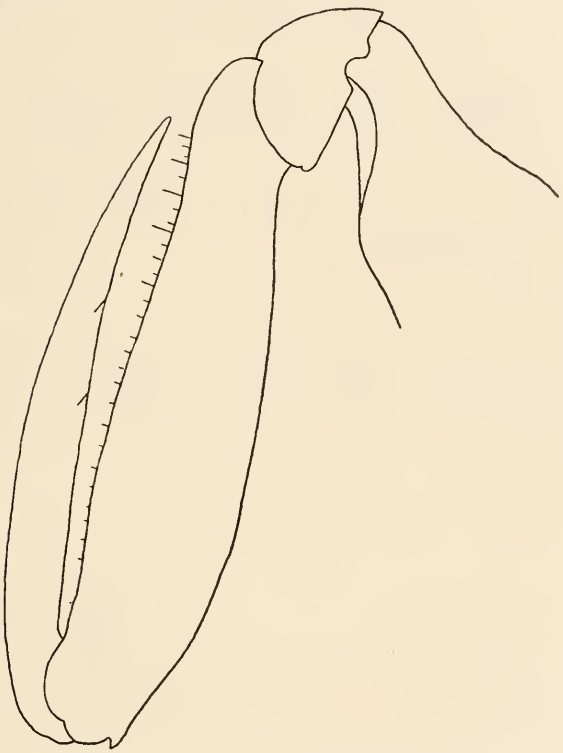

FIG. 7.— Raptorial limb of *P. ornata* in the postlarval stage.

than its median length. The telson is smooth above except for a low median crest that ends in a sharp spine a *considerable distance* (0.25 mm.) from the posterior margin, as in *P. ciliata,* and the lateral margin is slightly raised, forming a carina. The posterior margin is like that in *P. ciliata,* and bears about thirty-two minute spinules. The intermediate and lateral denticles on the inner sides of the corresponding marginal teeth are well developed and acute. The uropods are like those of *P. oculata* (see below). The outer spine of the basal process is *much longer* than the inner one, and its inner border is markedly sinu-

ous. The paddle of the exopod is about *one-third* (0.35 mm.) the length of the proximal segment, which on one limb bears nine movable spines and ten on the other. *Ten* seems to be the normal number.

The dorsal process on the basal segment of the antennae is more erect than in *P. ciliata* and its ventral margin is somewhat *convex* as in the adult. The distal spine on the propodus of the raptorial limb is not so prominent as in *P. ciliata* and *P. oculata*, not extending beyond the articulation (Fig. 7), and the ventral margin of the carpus projects strongly, suggesting the spine characteristic of the adult. The posterior border of the carapace is evenly concave, and bears a minute tubercle on the median line. The postero-lateral angles of the first to third abdominal somites are rounded, of fourth and fifth spinous, and the sixth abdominal somite bears the submedian and lateral spines characteristic of this stage.

Measurements of this specimen are given in the table below with those of the adult.

Distribution.— The two specimens in the present collection are both from Apia, Samoa. The species has been reported from Samoa by Ortmann and by Parisi. It was first taken at Tahiti, and occurs as far west as Mauritius and north to Japan, but has not been recorded from the Hawaiian Islands.

Table of Measurements

Station: Apia, July, 1902.	Specimen No.	46	19*b*
	Sex	♀	♂ juv.
		mm.	mm.
Total length, median line		69.0	20.5
Carapace, length		15.0	3.92
Carapace, breadth		10.5	2.83
Rostrum, length		2.5	1.20
Rostrum, breadth		4.4	1.40
Fifth abdominal somite, breadth		10.5	—
Fifth abdominal somite, dorsum to ventral spine		8.0	—
Telson, median length		7.0	2.83
Telson, length to tip of submedian spine		10.6	—
Telson, length to base of mobile spine		—	3.17
Telson, breadth		8.5	2.67
Telson, depth at anus		3.5	—
Eye, vertical diameter		—	1.32
Eye, longitudinal diameter		—	1.88
Antennal scale		7.7	1.80
Uropod, length proximal segment of exopodite		7.0	1.92
Uropod, length distal segment of exopodite		2.5	0.68

Pseudosquilla oculata (Brullé)

Squilla oculata Brullé in Webb and Berthelot's Iles Canaries, Zoöl., 1836–44, **2**, Crust., p. 18, fig. 3.
Squilla monodactyla A. Milne-Edwards, Bull. Soc. Philom., Paris, 1878, (7), **2**, p. 232.
Pseudosquilla oculata Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, p. 110, pl. 3, figs. 3, 4.
Pseudosquilla monodactyla Miers, *ibid.*, 1880, pp. 110–111, pl. 3, figs. 1, 2.
Pseuderichthus distinguendus Hansen, Isop. Cumac. u. Stomatop. Plankton Exped., 1895, p. 86.
Pseuderichthus distinguendus Jurich, Stomatop. Deutsch. Tiefsee-Exped., 1904, pp. 394–395, pl. 27, fig. 5.
Pseudosquilla oculata Kemp, Mem. Indian Mus., 1913, **4**, pp. 102–103, 108.
Pseudosquilla oculata Pesta, Denk. K. Akad. Wiss. Wien., 1914, **89**, p. 682.
Pseudosquilla oculata Bouvier, Bull. Sci. France et Belg., 1915, **48**, p. 311.
Pseudosquilla oculata Edmondson, Occ. Papers Bishop Mus., 1921, **7**, pp. 290–292.
Pseudosquilla oculata Odhner, Göteborgs Vet. Handl., (4), 1923, **27**, p. 6.
Pseudosquilla oculata Edmondson, Bull. Bishop Mus., 1925, No. 27, p. 59.

Postlarval Stage.— Not a single adult specimen of *Pseudosquilla oculata* is to be found in the present collection, although the species has been reported from Samoa by de Man (1891) and by Pesta (1914), and Edmondson reports (1921) eleven specimens in the Bishop Museum from Oahu and (1925) sixty-eight specimens collected by the "Tanager" expedition among the leeward Hawaiian Islands to the northwest of the main group.

While apparently less abundant, this species seems to be as widely distributed as *P. ciliata*, having been found at the Cape Verde Islands and at Madeira in the eastern Atlantic, as well as in the Indo-Pacific region from Samoa, the Society Islands, and Hawaii to Mauritius. Odhner (1923) has extended the known distribution to the Gilbert and the Bonin Islands.

The adult form is distinguished from both *P. ciliata* and *P. ornata* by the presence of an apical spine on the rostrum and an additional longitudinal carina on the telson. It resembles *P. ornata* in having the outer spine of the basal process of the uropod longer than the inner one, and in the presence usually of ten to eleven movable spines on the exopod (Hansen, 1895, p. 86). The eyes are also flattened as in *P. ornata*, but are shorter and more thick-set; and the ultimate segment of the uropod is even smaller than in *P. ornata*, being much less than half the length of the proximal segment of the exopod (Kemp, 1913,

p. 102). The largest adult recorded by Edmondson (1921) is a female 55 mm. long, and by Odhner (1923) a male of 50 mm.

Hansen (1895, p. 85), by comparison with the type specimens of both authors, has identified the postlarval stage of this species with *Squilla monodactyla* A. Milne-Edwards (1878) and *Pseudosquilla monodactyla* Miers (1880). It differs from the *monodactyla* stage of *P. ciliata* by its larger size, 28–34 mm. (Kemp, 1913, p. 108); and by the possession of ten to eleven lateral spines on the uropod.

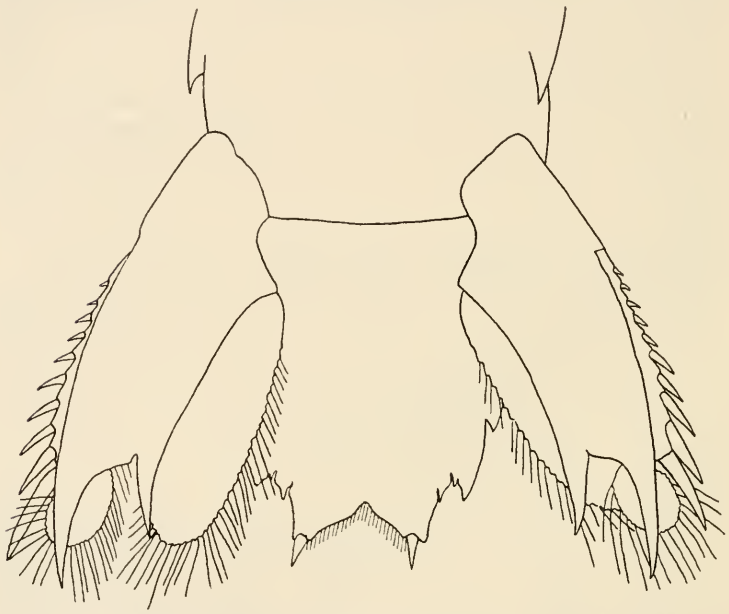

Fig. 8.— Telson and uropods of *P. oculata* in the postlarval stage, ventral aspect.

The collection from the Hawaiian Islands contains nineteen specimens, 24–30.7 mm. in length that appear to be in the *monodactyla* stage of *P. oculata*. They were taken from the surface at six stations during the hours from 7.30 to 8 P.M. or in the early morning (4.15 A.M.).

In addition to the greater length, these specimens differ from the corresponding stage of *P. ciliata* in the form of the rostrum, which is acute at the apex, and about eight tenths as long as wide. With one exception, the outer margin of the uropod is armed with ten or eleven movable spines. The exceptional individual has eight on one side and

ten on the other. The paddle of the exopod is noticeably smaller than in *P. ciliata;* in an average of eleven specimens it is thirty-five hundredths the length of the proximal segment, and the outer spine of the basal process is stronger and its inner border is more sinuous (Fig. 8). The posterior border of the telson shows the median indentation mentioned by Jurich (1904) as characteristic of the *Pseuderichthus* stage and bears thirty-three to thirty-five minute spinules of nearly uniform size. The dorsal surface of the telson is marked by a well defined median crest that extends nearly the full length of the telson and ends in a sharp spine *very close* to the posterior margin (within 0.06 mm.).

On each side of the median crest there is a trace of the intermediate carina, and on one specimen beteeen this and the crest a longitudinal line of pits could be detected.

The eyes are pyriform in lateral view and slightly flattened on the inner side, the maximum vertical diameter being about three-fourths the length.

The raptorial limb is like that of *P. ciliata* (Fig. 6) with a strong terminal spine on the propodus, and beneath the integument of the dactylus are the rudiments of two lateral teeth, faintly indicated in the smaller specimens and well marked in the larger ones. The posterolateral angles of the first to third abdominal somites are rounded, of the fourth and fifth spinous; and on the sixth somite are pairs of submedian and lateral spines, but no intermediate.

List of Stations and Specimens — 1902

Station 3,812 south coast of Oahu	March 27, 7.30 P.M.	3 specimens
Station 3,829 south coast of Molokai	April 1, 8 P.M.	1 specimen
Station 3,837 south coast of Molokai	April 3, 8 P.M.	1 specimen
Station 3,921 off Honolulu, Oahu	May 6, 8.45 P.M.	11 specimens
Station 3,932 off Laysan Island	May 16, 4.13 A.M.	1 specimen
Station 4,086 off Maui	July 21, 7.46 P.M.	2 specimens

These observations, with those of Edmondson (1925), indicate a wide distribution of the species in the Hawaiian Islands, and that while in the *monodactyla* stage it tends to swim at the surface at night. Of the one hundred and sixty-five specimens in this stage, mentioned without description by Edmondson, all but one were taken at two stations of the "Tanager" expedition, one hundred near Pearl and Hermes Reef and sixty-four off Johnston Island (see map, Bishop Mus. Bull. 10, p. 20), and like our specimens were collected from the surface at night.

Table of Measurements

Specimen no.	58*b*	58*c*	58*d*	59	60*a*	60*b*	61*a*	61*b*	61*c*	61*d*	61*e*	62	63
Station	3812	3812	3812	3837	4086	4086	3921	3921	3921	3921	3921	3829	3932
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Total length	25.2	24.0	24.0	..	30.7	..	..	..	..	..	..		
Carapace length	4.91	4.91	5.08	4.91	6.68	5.40	4.75	5.25	5.08	5.75	5.17	4.92	5.25
Rostrum length	1.42	..	..	..	..	..	..	..	..	..	..	..	..
" breadth	1.67	..	..	..	..	..	..	..	..	..	..	..	
Telson median length	2.67	..	..	..	4.17	..							
Telson to base mobile spine	3.08	..	..	..	..	..							
Telson breadth	3.24	..	..	..	4.17	..							
Eye vertical diameter	1.50	1.50	1.50	1.50	1.75	..	1.50	1.42	1.58	1.50	1.67	..	1.58
Eye longitudinal diameter	2.00	2.08	2.08	2.00	2.16	..	2.08	2.00	2.00	2.16	2.00	..	2.00
Uropod prox. seg. exopod.	2.25	2.41	2.33	2.50	3.25	2.40	2.08	2.25	2.41	2.25	2.50	2.41	2.50
Uropod distal seg. exopod.	0.83	0.83	0.92	0.75	1.00	0.96	0.83	0.83	0.75	0.92	0.83	0.75	0.83
Dactylus with subdermal teeth	+	+	+?	−	+	+	+	?	+	+	+	?	?
Number movable spines on uropod	10	10	10	10	11	10	8–10	10	10–11	11	10	10	10–11
Telson with low intermediate carinae	−	+	+?	?	+	?	+	+	−	+	+	+	−

NOTE: The last decimal figure is approximate. The sex in all specimens is indeterminate.

LYSIOSQUILLA Dana

Coronis Latreille, Encycl. Meth. Hist. Nat., 1825, **10,** p. 474 (*nom. praeocc.,* Hubner, 1816).

Squilla (*Squilles fine-tailles, 1st sect.*) H. Milne-Edwards, Hist. Nat. Crust., 1837, **2**, pp. 518–519, pl. 26, fig. 11.

Lysiosquilla Dana, U. S. Expl. Exped., 1852, **13**, Crust., p. 615.

Lysiosquilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 502.

Lysiosquilla Kemp, Mem. Indian Mus., 1913, **4**, p. 109.

Lysiosquilla Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 18.

Diagnosis.— Stomatopoda having the body flattened, loosely articulated, and wide — without longitudinal carinae; mandibular palp composed of three segments; merus of raptorial limb articulating terminally with ischium, ventral surface of merus longitudinally hollowed throughout its length, upper margin of propodus finely pectinate, dactylus not inflated at its base and armed with at least five marginal teeth; manus of third thoracic leg large, its outer surface three to four times larger than that of the fourth leg; telson broader than long, with few intermediate denticles or none; inner spine of basal process of the uropods usually longer than the outer one, rarely suppressed.

Type Species.— *L. maculata* (Fabr.).

Species Represented in the Collection.— *L. maculata* (Fabr.).

Lysiosquilla maculata (Fabricius)

Squilla arenaria terrestris Rumphius, Amboinische Rariteitkamer, 1705, p. 4, pl. 3, fig. E.

Squilla maculata Fabricius, Ent. Syst., 1793, **2**, p. 511.

Cancer (mantis) arenarius Herbst, Nat. Krabben in Krebse, 1796, **2**, p. 96, pl. 33, fig. 2.

Lysiosquilla maculata Dana U. S. Expl. Exped., 1852, **13**, Crust., p. 616.

Lysiosquilla maculata Kemp, Mem. Indian Mus., 1913, **4**, pp. 111–116, pl. 8, figs. 86–91 (with references complete to 1910).

Lysiosquilla maculata Kemp, Philip. Jour. Sci., (D), 1915, **10**, p. 174.

Lysiosquilla maculata Alexander, Jour. and Proc. Roy. Soc. W. Australia, 1916, **1**, pp. 8, 9, 10.

Lysiosquilla maculata Sunier, Contr. Faune des Indes Neérl., 1918, **4**, p. 72, fig. 4.

Lysiosquilla maculata Edmondson, Occ. Papers, P. B. Bishop Mus., 1921, **7**, pp. 292–295.

Lysiosquilla maculata var. *sulcirostris* Parasi, Atti Soc. Ital. Sci. Nat., 1922, **61**, p. 105.

Lysiosquilla maculata Odhner, Göteborgs Vet. Handl. (4), 1923, **27**, (4), p. 7.

Lysiosquilla maculata var. *sulcirostris* Monod, Bul. Soc. Sci. Nat. Moroc, 1925, **5**, pp. 88–89, pl. 21, fig. B–E.

Lysiosquilla maculata Hansen, Siboga-Exped. Monogr., 1926, **35**, (Livr. 104), pp. 18 and 39–40.

Lysiosquilla maculata Komai, Mem. Col. Sci., Kyoto Imp. Univ. (B), 1927, **3**, p. 330.

Diagnosis.— A *Lysiosquilla* without dorsal spines on the telson, the whole dorsal surface of the animal smooth and polished; carapace strongly arched, almost as broad anteriorly as posteriorly, gastric grooves sharp, and cervical groove obsolete; rostrum nearly as broad

or broader than long, cordiform, smooth except for a longitudinal carina in the anterior third; eyes large; three soft papillae on the antennal protopodite; raptorial dactylus in males and young females with nine to eleven long teeth, including the apical one which is not dilated, on the propodus near its proximal end four movable spines; in old females the lateral teeth of the dactylus reduced and the distal pair of movable spines on the propodus reduced or wanting; mandibular palp composed of three segments; shorter ramus of last three thoracic limbs linear; thoracic somites without longitudinal wrinkles, the third and fourth somites exposed; lateral margins of the first to fifth abdominal somites concave, their postero-lateral angles rounded; sixth abdominal somite with swollen lateral lobes, a median smooth area, and on either side sometimes a number of obscure and irregular elevations; at each antero-lateral angle a single strong tooth projecting backward over the ventral surface of the uropod; telson nearly twice as broad as long, with a feeble triangular elevation in both dorsal and ventral surfaces, posterior margin of telson with two to four blunt or acute processes on each side of an indistinct median notch; the basal process of the uropods ending in two long spines, triangular in section and bearing three longitudinal grooves and three carinae, the inner spine nearly twice the length of the outer one; the proximal segment of the uropod with a terminal fixed spine on the ventral side and eight or nine movable spines on its outer margin.

General Description.— The diagnosis given above is a modified abstract of the very full description by Kemp (1913). Our collection contains nine specimens: one male and two females from Samoa; three males and three females from Honolulu. Of these, the largest is a female from Apia, measuring 285 mm. in length.

One large male (258 mm.) has nine teeth on the right raptorial claw and ten on the left, including the apical one. Another male has eleven teeth on both claws, and the other two have ten on the right claw and the left one missing. The smaller females have dactyli like the males with ten long teeth, but the two large ones from Samoa (240 and 285 mm.) have in one nine and the other eight short stout teeth on the dactylus.

The sexual modification of the raptorial limbs in the two large females mentioned above is not so marked as in Kemp's specimen (1913, pl. 8, fig. 90). The teeth on the dactylus are longer, probably like his specimens from the Philippines (1915, p. 174), and the propodus bears four movable spines. These differ, however, from those in the males and smaller females, which are long and nearly evenly

spaced. In the large females they are arranged in two pairs — a proximal pair of two long spines placed close together, and a distal pair of very short spines. Each pair of spines is concealed in a dense tuft of long hairs (Kemp, fig. 90) that arise from the medial edge of the marginal groove, where in other specimens there are only a few scattered hairs.

Perhaps like other collections (Parisi, 1922; Monod, 1925), our specimens are in the form of the rostrum, more or less intermediate between the extreme types figured by Kemp (1913, pl. 8, figs. 86 and 92). Our nine specimens show considerable variation with a tendency

FIG. 9A FIG. 9B

FIG. 9.— Rostrum and anterior margin of the carapace of *L. maculata*. *A*. Female 285 mm., *B*. Male, 258 mm. x 3. The eye-spot on the carapace is indicated by the circle of dashes.

toward two types correlated with sex and age. The extremes are shown by the two largest specimens, a female 285 mm. (Fig. 9A), and a male 258 mm. (Fig. 9B). In the female the rostrum is distinctly broader than long, but the apex is more acute than in Kemp's typical form, and there is a very small apical carina not bordered by grooves. The rostrum of the male is about as long as it is broad, with the apex strongly produced, subacute and slightly depressed, and bearing a well marked carina bordered by grooves that diverge posteriorly and extend from the apex nearly to the middle of the rostrum. One of the smaller females (No. 47, 175 mm.) has a rostrum like the males, but all the other females resemble the large one and may be classed with Kemp's typical form, while all the males are more or less alike and might be assigned to Kemp's var. *sulcirostris*, with respect to the rostrum, although they differ from the type of the variety in the number

of teeth on the raptorial dactylus. As suggested by Monod (1925), it is probable that these two characters vary independently.

Another feature in which there is a sexual difference increasing with size has been noticed by Kemp (1913, p. 114). This is in the size of the eyes, which are relatively much smaller in large females than in males of the same size. This is well illustrated by the two large females from Samoa, with a marked increase in Kemp's corneal index (the number of times that the breadth of the cornea is contained in the median length of the carapace), as shown in the table below.

In all of our specimens the sixth abdominal somite appears to be normal, and the outer marginal teeth of the telson are strongly produced and acute.

The uropods of this species have a peculiarly distorted appearance, the exopodite being short and swollen with the movable spines, eight in all of our specimens, arranged in a curved row so that the line of attachment of the distal three spines is nearly at a right angle to the proximal line.

Color.— All of our specimens show the alternate dark and pale bands characteristic of preserved specimens of this species, but with some variations. No specimen is as dark as Kemp's Figure 87, and on every specimen there is a pale patch on the sixth abdominal somite which he states to be, as a rule, wholly pigmented. In the dark band close to the anterior margin of the carapace there is a median eye-spot, nearly half as wide as the rostrum (Fig. 9). It consists of an area of lighter pigment surrounded by a circle of dense pigment. I am informed by Professor R. P. Cowles, who spent many years in the Philippines, that in life the dark bands are slate-color, almost black, and the pale bands are a yellowish cream-color.

Larval Stages.— Hansen (1926) agrees with Brooks (1886) in the inference that the large larval form *Lysiocrichthus duvaucellii* (Guérin) is the young of this species, although definite experimental evidence is wanting.

Distribution.— The specimens in the present collection are three males and three females from Honolulu, and one male and two females from Apia in the Samoan Islands. This species is one of the most widely distributed of the stomatopods. The first record from Hawaii is by Randall (1839), and from Samoa by Miers (1879). Kemp (1913) gives a list of ten localities represented by specimens in the Indian Museum, and of twenty recorded by other observers. With one exception, these lie within the Indo-Pacific region, from Durban, South Africa, to the Riu Kiu Islands south of Japan, and from Rodriguez in the Indian

Ocean through the Malay area and the Pacific Islands to Fiji, Tahiti, the Marquesas, and Hawaii. Duke of York Island (Miers, 1877) is now called New Lauenburg. The exception is a specimen sent to Stebbing from Antigua, British West Indies. It exhibits some peculiarities that may indicate a distinct variety. The only other record from the Atlantic region is a specimen identified as var. *sulcirostris* that was collected by Monod (1925) off Cape Blanco, Mauritania. Since the publication of Kemp's monograph, a number of additional records in the Indo-Pacific region have been made by Sunier, Edmondson, Kemp, Parisi, Odhner, Hansen, and Komai; and Alexander has extended the known distribution to King Sound, western Australia. In some places the species is abundant and forms the object of a fishery, as at Honolulu.

Size.— This is the largest of the stomatopods. Specimens over 200 mm. long are not uncommon, and Hansen (1926) reports a male from the Banda Sea 315 mm. in length. The dimensions of our specimens are given in the following table.

Table of Measurements

Station	Serial number	Sex	Total length	Carapace length	Cornea		Rostrum		Number of teeth on raptorial dactylus including terminal one	
					Breadth	Index Kemp '13 p. 9 and 114	Length	Breadth		
			mm.	mm.	mm.	mm.	mm.	mm.	R.	L.
Honolulu, 1901	47	♀	160	30.0	7.4	4.1	6.0	6.3	10	10
" Market, 1902	48	♂	199	37.5	9.2	4.0	8.5	8.5	10	..
" " March 26, 1902	49	♂	212	39.5	9.0	4.4	8.5	8.0	10	..
Honolulu Market, June 25, 1902	50*a*	♂	181	36.0	9.5	3.8	8.2	7.5	11	11
Honolulu Market, June 25, 1902	50*b*	♀	191	36.0	7.5	4.8	6.5	7.2	..	..
Honolulu Market, July 25, 1902	51	♀	175	28.0	7.5	3.7	6.5	6.0	10	10
Apia, Samoa, 1902	52	♂	258	50.0	11.0	4.5	10.0	10.2	9	10
" "	53*a*	♀	285	52.4	9.3	5.6	7.3	10.3	9	9
" "	53*b*	♀	240	48.0	8.6	5.6	7.8	9.5	8	8

SQUILLA J. C. Fabricius
or CHLORIDELLA Miers

Not *Squilla* L. T. Gronov 1760 and 1764.
Not *Squilla* O. F. Müller 1776.

La squille Rondelet, Histoire entier des poissons, part 1, 1558, pp. 396–398, fig., p. 397.
Squilla Seba, Locupletissimi rerum naturalium Thesauri, 1758, **3**, pp. 50–51, pl. 20, fig. 2, 3, 6 (*partim*).
Squilla DeGeer, Mémoires pour servir à l' Histoire des Insectes, 1778, **7**, p. 533, pl. 31, fig. 1 (*partim*).
Squilla J. C. Fabricius, Mantissa Insectorum, 1787, **1**, p. 333 (*partim*).
Squilla Lamarck, Systême des animaux sans vertébres, 1801, p. 160 (*partim*).
Squilla Latreille, Histoire naturelle des Crustacés et des Insectes, 1802, **3**, p. 36; 1803, **6**, pp. 271–281 (*partim*).
Squilla Latreille, Encycl. Méthod., 1825, **10**, p. 467 (*partim*).
Squilla Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, p. 16.
Chloridella Miers, *ibid.*, 1880, p. 12.
Squilla Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p. 23.
Squilla Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 509.
Squilla Hansen, Isop. Cumac. u. Stomatopoda Plankton Exped., 1895, p. 69.
Chloridella Rathbun, Proc. U. S. Nat. Mus., 1902, **26**, p. 54.
Squilla Stebbing, Ann. S. Africa Mus., 1910, **6**, p. 405.
Chloridella Rathbun, Proc. U. S. Nat. Mus., 1910, **38**, pp. 565, 608.
Squilla Kemp, Mem. Indian Mus., 1913, **4**, pp. 16–19.
Squilla Kemp, Philippine Jour. Sci., (D), 1915, **10**, p. 169.
Squilla Calman, Brit. Antarct. ("Terra Nova") Exp., 1910, Nat. Hist. Rep. Zoöl., 1917, **3** (5), pp. 137–162.
Squilla Sunier, Contr. Faune Indes Néerl., 1918, **1**, (4), pp. 65–72.
Squilla Kemp and Chopra, Rec. Ind. Mus., 1921, **22**, pp. 297–311.
Squilla Edmondson, B. P. Bishop Mus. Occ. Papers, 1921, **7**, (13), pp. 287–288.
Squilla Parisi, Atti Soc. Ital. Nat. (Milano), 1922, **61**, pp. 91–103.
Squilla Odhner, Göteborgs Vet. Handl., (4), 1923, **27**, (4) pp. 1–6.
Squilla Monod, Bul. Soc. Sci. Nat. Moroc., 1925, **5**, pp. 86–88.
Squilla Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 3.
Squilla Komai, Mem. Coll. Sci., Kyoto Imp. Univ. (B) 1927, **3**, (3), pp. 308–323.

Diagnosis.— *Stomatopoda* having the hind body depressed, with longitudinal carinae; carapace narrower in front than behind, with gastric and cervical grooves, and more or less distinct longitudinal carinae; cornea of eyes usually bilobed; mandibular palp three-segmented or absent; merus of raptorial claw articulating terminally with ischium; upper margin of propodus finely pectinate or with a series of

long stiff spines; dactylus not inflated, with teeth on inner margin; shorter ramus of last three thoracic appendages linear, with or without an imperfect suture between basal and distal parts; telson with median carina, the dorsal surface on either side smooth, pitted, tuberculate or carinate, and the posterior margin with three pairs of large teeth, and on each side of median line one or more submedian denticles, more than four intermediate, and one lateral; ventral process of uropods terminating in two sharp spines, of which the inner one is the longer.

Remarks on Nomenclature.— The genus *Squilla* J. C. Fabricius, or *Chloridella* Miers, is not only as stated by Kemp (1913), from whom the above diagnosis is quoted in part, the oldest established, but also is the most numerous in species, and the most typical genus of the order. Kemp thinks it also the most primitive. As established by Fabricius in 1787, it contained exclusively all the Stomatopoda then known, including the common European form that had been described in 1778 by DeGeer under the name *Squilla mantis*. The genus is described, and five species, with references to previous descriptions and figures.

The genus *Squilla* of Fabricius was accepted by Lamarck in 1801, and by Latreille in 1802, and the name then given to the typical genus of Stomatopoda remained unquestioned for more than a century. It was in 1899 that Miss Rathbun called attention to O. F. Müller. Later Sherborn (1902, p. 926) found that the first application of the name "Squilla" to a genus of animals made after January 1, 1758[1] was by L. T. Gronov, 1760. One species was defined "*Squilla acaudata pedibus quatuordecim*" with a very good figure of an amphipod afterward described by Slabber (1769) as *Phtisica marina* and by O. F. Müller (1776) as *Squilla ventricosa* (Stebbing 1888, p. 19; 1910, p. 405).

From early times the name "la squille" or "*Squilla*" seems to have been applied by fishermen to various shrimp-like animals. This usage is reflected by Rondelet (1558), who includes under this name several shrimps and prawns including (p. 396–398, fig.) the mantis shrimp, *Squilla mantis*. Later, when they became known to naturalists, various species of amphipods and isopods were included in this comprehensive genus Squilla — for example Seba (1758) and DeGeer (1778).

In revising the genus Squilla, Fabricius (1793) refers to Seba (1758), and the latter seems to have priority over Gronov (1760), whose standing as a binomialist is perhaps equally open to question (see International Rules 1926, Opinion 89). The reference is to plate 20, figs. 2, 3, and 6. Figures 2 and 3 are supposed to represent *Squilla mantis*

[1] Rules, Art. 26, and Opinion No. 3.

DeGeer, but figure 2 is without doubt *S. raphidea* Fabricius (1798), and figure 3, with five teeth on the dactylus and the lateral process of the fifth thoracic somite strong, acute, and very slightly curved forward, is more like *S. prasinolineata* or *S. defresnii* Miers. Figure 6 is *Odontodactylus scyllarus* (L.).

The definition of Gronov (1760) has generally been ignored, except by Scopoli (1777) who includes it in a list of genera, without mentioning any species. The revision of Fabricius was welcomed with enthusiasm by Latreille (1803, p. 271), who, after discussing the previous usage, says: "Fabricius has finally removed this confusion, and the genus of the squilles is now circumscribed in convenient limits, being perfectly natural."

Fabricius in 1793 included in the genus five species. The first, *S. maculata*, has been placed in the genus Lysiosquilla Dana (1852); the second, *S. mantis* (L.) DeGeer (1778)[1], remains the type of the genus Squilla; the third, *S. scyllarus* (L.), and the fifth, *S. chiragra*, were placed by Latreille (1825) in his new genus *Gonodactylus;* and the fourth of these species, *S. ciliata*, was added (under another name) by Dana (1852) to his genus *Pseudosquilla*. In 1841, Eydoux and Souleyet proposed the generic name *Chlorida* for some species with very small eyes. Finding this name preoccupied, Miers (1880) changed it to Chloridella. But Brooks found (1886) that these forms are linked to the typical species of *Squilla* by such forms as *S. lata* and *S. fasciata.* Miss Rathbun (1902) regards the name *Squilla* as a homonym (Rules, Art. 23) and the name *Chloridella* as the only available one for the genus, but this has been disputed by Stebbing (1910), and has not generally been admitted.

In his monograph of the Stomatopoda, Kemp (1913, p. 3) gives a list of fifty-four known species and varieties of *Squilla*. In spite of the addition of many new species, the limiting characteristics of this genus have remained practically unchanged since the publication of the "Challenger" Report (Brooks, 1886), and in nearly all important monographs and other papers from 1793 to the present time, the name Squilla has represented a genus of Stomatopoda that contains the common European form, the type species. The various unrelated eighteenth century species associated with this name have long since been discarded into the synonymy, or have been placed in other genera.

It is evident, therefore, that to substitute for this familiar name another, in "strict application of the rules, will clearly result in greater

[1] See Sherborn, 1902, p. 583.

confusion than uniformity" (Rules, 1926, p. 88). For this reason, the name *Squilla* is retained here, and a petition is being presented to the International Commission on Zoölogical Nomenclature to suspend the rules as applied in this case.

Calman, 1917, first drew attention to the importance of the number of epipodites on the thoracic limbs as a specific criterion in the genus Squilla. Kemp and Chopra (1921) [1] have followed up this suggestion by examining all the forms represented in the Indian Museum, and they give lists of species, — in five species epipodites are found on the first five thoracic limbs; in thirty, on the first four; in one, on the first three; and in three, on the first two only. They also indicate those species lacking a mandibular palp. They conclude that, while these two characters have definite specific value, they cannot be used as a guide to the affinities of the different forms.

Type Species.— *Squilla mantis* (L.) DeGeer, 1778; (Sherborn, 1902, p. 583); Latreille, 1802.

Species Represented in the Collection.— *S. mauiana* n. sp.; *S. polita* Bigelow; *S. oratoria* De Haan.

Squilla mauiana spec. nov.

Provisional Diagnosis.— A *Squilla* with small eyes, the cornea bilobed and nearly transverse, its axis about two-thirds the length of the eye-stalk; ophthalmic somite exposed, with dorsal processes meeting in the median line and closely applied to the base of the eye-stalks, distal edges straight and meeting at nearly a right angle; antennal scale when extended reaching to anterior margin of cornea; mandibular palp absent; raptorial dactylus with five long marginal teeth, including the terminal one, and a prominent external tuberosity near the articulation; propodus strongly pectinate and bearing three long movable spines; carpus with a dorsal crest ending in a small spine, the ventral external margin of the merus rounded; epipodites present on the first and second thoracic limbs; hand of fourth thoracic limb longer than broad and larger than the fifth; rostrum smooth, about as broad as long, with sides converging slightly toward the semicircular apex; carapace smooth, with well marked gastric and cervical grooves; anterior margin angular, from gastric groove outward transverse; antero-lateral angles square, postero-lateral lobes rounded and bordered

[1] Cf. also Hansen (1926, p. 1).

by a marginal carina, lateral and posterior margins concave, a small but distinct median tubercle at posterior margin; exposed thoracic somites smooth, lateral margin of the fifth slightly produced as a short subvertical lateral keel quite separate from the prominent, acute, procurved ventrolateral spine; lateral margins of sixth and seventh thoracic somites truncate and slightly thickened at edge; the appendages of the walking legs are broad and flat with parallel sides; first to fifth abdominal somites without submedian carinae, intermediate carinae slightly developed on third to fifth somites, lateral and marginal carinae present on all five somites; on the fifth the postero-lateral angles are spinous; sixth abdominal somite with very low submedian, intermediate, and lateral carinae ending in spines, and in addition a transverse row of small spines at the posterior margin; telson with six marginal teeth, the submedian pair having mobile tips, denticles 5, 8–9, 1, acute; dorsal surface of telson convex with a large elevated central area and a lower marginal area separated by a transverse declivity parallel to the margin and becoming less abrupt laterally; in the center of the elevated area a shield-shaped figure formed by a pair of grooves that converge under the spine at the posterior end of the low median crest; on the edge of the shield near the posterior ends of the grooves, a row of a few small spines; at the brink of the declivity a row of five or six stout, acute spines on each side of the telson at the posterior ends of very short longitudinal carinae; the narrow marginal area of the telson crossed by the dorsal carinae of the submedian and intermediate marginal teeth, marginal carinae present; ventral surface of telson slightly roughened on each side of a single postanal keel; the basal segment of the uropods with a dorsal longitudinal carina bearing three to four spines, the distal one being at the articulation with the exopodite, on the dorsal surface of which the ridge extends and there bears three small spines; basal process of the uropods armed on the inner margin with about sixteen elongated, sharp spines, and terminating in prongs, of which the inner one is much the longer and nearly reaches the apex of the paddle; both prongs broad toward the base with a prominent adaxial lobe on each one, the terminal slender portion of the inner prong being longer than the same part of the other; proximal segment of the exopodite with seven or eight movable spines, the distal one being more than three-fourths the length of the paddle, the endopodite narrowly spatulate and its entire border beset with setae.

Special Description.— One naturally hesitates before describing as new a species represented by a single, immature, and mutilated speci-

men. The specimen in question is a male (our No. H. 57) 21.27 mm. in length, from Hawaii. It has lost one entire raptorial limb and the distal part of the dactylus of the other, also some other minor parts. The intromittent organs are fairly well developed, their tips meeting at the median line.

In spite of its somewhat immature condition this specimen exhibits a peculiar combination of characters that appear clearly to distinguish it from any species of which I have been able to find a published description. It resembles *Squilla chlorida* Brooks, also known from a unique small male (39.9 mm.), but its nearest relative is *S. incerta* Hansen (1926). From this species it differs in a number of particulars that may be summarized by saying that it has more spines and fewer carinae. These might be regarded as juvenal characteristics. But Hansen's specimen, also a male, is only 24 mm. in length, less than 3 mm. larger than ours, and there cannot be much difference in age. Moreover, there are some differences that can hardly be attributed to that cause. That the two forms are specifically distinct is also made probable by the great distance between the localities where they were found. The two forms are alike in the shape of the eyes, the structure of the antennae, absence of mandibular palps, structure of the raptorial and other thoracic limbs, shape of rostrum, margins of thoracic somites, general smoothness of dorsal surface from carapace to abdomen, arrangement of sculpturings on the telson, and form of the uropods (Fig. 10).

In detail there are many differences. Although mutilated, from the structure of the propodus it is evident that the dactylus of the left raptorial claw had five teeth including the terminal one, not six — the right claw is lost. The epipodites are present on only the first and second thoracic limbs, but they may have dropped off from the others. Hansen's specimen has them on the first four pairs.[1] In our specimen there are no traces of a carina on the rostrum, of lateral carinae on the carapace, or of intermediate carinae on the exposed thoracic somites. All carinae on the abdominal somites are poorly developed and difficult to observe. The postero-lateral angles of the fifth abdominal somites are provided with a minute spine below a rounded lobe. On the sixth abdominal somite the usual six spines are prominent in our specimen, but the corresponding carinae are very poorly developed or absent, and this segment has a peculiar feature at the posterior margin where it joins the articular membrane. This is a row of minute sharp spines. There are three or four between the submedian and intermediate spines,

[1] Hansen's notation differs from Kemp, whom we follow.

and one or two between the intermediate and lateral. The number of marginal denticles on the telson is greater than in *S. incerta*, and on the dorsal surface the "pair of carinae converging backward" of that species is represented in our species by a series of small spines; there is no trace of the "parallel keel," and the four "short longitudinal

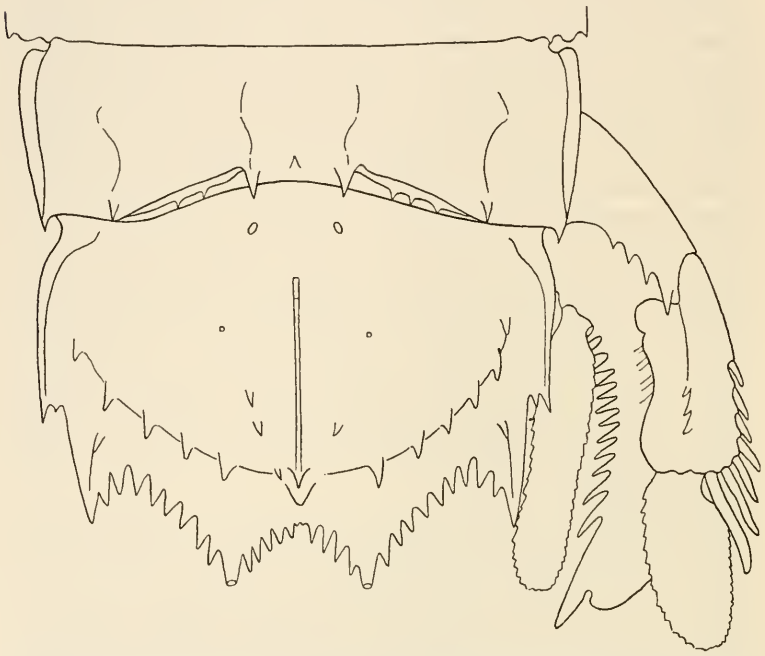

FIG. 10.— *Squilla mauiana* type. Sixth abdominal somite, telson, and uropod; dorsal aspect, x 8. Outline of central shield indicated by position of small spines near the median crest; dorsal carinae of submedian marginal teeth not shown.

keels", terminating a little from the hind margin, are represented by a transverse series of stout, sharp spines — six to the right and five to the left of the median line. These spines point directly backward and at their bases are continuous with very short carinae. Hansen does not mention spines in this position and his figure clearly indicates their absence. In the marginal area the intermediate, as well as the submedian, teeth bear carinae on the dorsal surface. On the uropods the most peculiar feature is the series of spines on the dorsal carina of the basal segment and of the first segment of the exopodite. This seg-

ment on its outer margin carries seven or eight movable spines, instead of five or six, the number of sharp spines on the inner margin of the basal process is about sixteen, instead of eleven or twelve, and the apical part of its inner prong is longer than the outer one.

This species resembles also *S. fallax* Bouvier (1914), from which it differs in the number of teeth on the dactylus, sculpturing of the telson, and the form of the uropods. It is like *S. fasciata* De Haan and *S. miles* Hess, but differs from both, as it does also from *S. chlorida* Brooks, in the sculpturing of the telson and in many other particulars. It differs in the shape of the eyes from *S. rotundicauda* Miers and from *S. microphthalmia* H. Milne Edwards.

Locality.— The single specimen, a male, was taken by the "Albatross" with the beam trawl April 14, 1902, at station 3,876 in Auau Channel between Maui and Lanai Islands (Hawaiian group) in 28–43 fathoms with sand and gravel bottom. Hansen's specimen of *S. incerta* was found at Siboga Exp. sta. 154, N. lat. 0° 7′, E. long. 130°25′, off Waigeu Island, northwest of New Guinea, depth 59–83 M., bottom muddy sand.

Table of Measurements

made with micrometer eyepiece

Specimen No. H 57 ♂ Station 3,876, April 14, 1902

Total length, median line	21.27 mm.
Eye, total length	1.44
Cornea breadth	1.04
Eye-stalk, breadth	0.88
Corneal index (Kemp's)	3.85
Antennal scale	1.52
Rostrum, length	0.76
Rostrum, breadth at base	0.72
Carapace, length median line	4.00
Carapace, breadth at antero-lateral angles	2.33
Carapace, maximum breadth	3.34
Length on median line, exposed thoracic somites	4.01
Length on median line, abdominal somites 1–6	10.00
Length on median line, telson	2.50
Breadth, fifth abdominal somite	4.25
Breadth, telson	3.75
First antenna, peduncle, length about	3.6

Propodus, fourth thoracic limb, 0.75 mm. broad, 1.08 mm. long
Propodus, fifth thoracic limb, 0.50 mm. broad, 0.90 mm. long
Uropods: basal segment, outer edge ..... 1.24 mm.
basal process inner side, articulation to tip of inner prong 2.16
length of paddle 1.33
length of endopodite 1.75

Squilla polita Bigelow

Squilla polita Bigelow, Johns Hopkins Univ. Circ. **10**, no. 88, 1891, p. 93–94.
Squilla polita Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, pp. 513–515, fig. 8.
Squilla polita Kemp, Mem. Indian Mus., 1913, **4**, p. 201.
Squilla polita Kemp and Chopra, Rec. Indian Mus., 1921, **22**, p. 298.

Diagnosis.— Eyes of medium size, triangular, with cornea set obliquely to the stalk; dactylus of raptorial claw with four teeth, including the terminal one; mandibular palp absent; epipodites present on the first four thoracic limbs; rostrum ovate without carinae; carapace without carinae, except on postero-lateral lobes, which are rounded; cervical suture obsolete on the median line, antero-lateral angles acute; lateral spine of the fifth thoracic somite broad, obtuse, and curved forward, the ventro-lateral spine elongated, curved forward and acute; lateral processes of the next two somites rounded; hind body without submedian carinae, except the sixth abdominal somite; telson with a dorsal crest and a ventral keel, with a few curved lines of pits on each side; six large marginal spines, the submedian pair having movable tips, and on each side of the median sinus two to four submedian denticles, nine to twelve intermediate, and one lateral one; inner spine of the basal process of the uropod nearly twice the length of the outer one, its basal half broad with a conspicuous rounded lobe on its outer side where it joins the slender distal half, proximal segment of the exopodite with five or six movable spines.

General Description.— It is unnecessary to repeat the extended description of the type forms (Bigelow, 1894). The one specimen in the collection, a male taken by the "Albatross" in Monterey Bay, differs from the type only in minor details. It has four submedian denticles on the telson and six movable spines on the uropod. It confirms the statement of Kemp and Chopra (1921) that the mandibular palp is absent and that the fifth thoracic limbs lack the epipodite. The corneal index (see p. 172) is 4.4.

The following abdominal carinae end in spines:

Carinae	*Abdominal somites*
Submedian	6
Intermediate	(3), 4, 5, 6
Lateral	3, 4, 5, 6
Marginal	4, 5

The present specimen is without distinctive pigmentation and there is no record of the color in life.

Distribution.— Our specimen, a male 48 mm. long, was taken by the "Albatross" with the tangle at depth of 46 to 54 fathoms in Monterey Bay, California, station No. 4,548, three miles off Point Pinos lighthouse. This is the most northern record for the species. Previous records are from Santa Rosa Island, California, and Point Abreojos, Lower California.

Size.— The largest specimen on record is 63 mm. in length (Bigelow, 1894).

Table of Measurements

Specimen No. E. P. 54 ♂, station 4,548, June 7, 1904.
Total length, median line, 48 mm.
Rostrum: length, 1.6 mm.; width, 1.8 mm.
Carapace: length, 11.0 mm.; width at antero-lateral angles, 5.7 mm.; maximum, 8.0.
Length exposed thoracic somites, median line, 7.5 mm.
Length six abdominal somites, median line, 22.0 mm.
Breadth fifth abdominal somite, 10.5 mm.
Telson: length median line, 5.2 mm.; maximum width, lateral spines, 9.0 mm.
Eye: inner margin, 3.0 mm.; cornea, 2.5 mm.; corneal index, 4.4.
Antennal scale, 4.5 mm.

Squilla oratoria De Haan

Squilla oratoria De Haan in Siebold's Fauna Japonica, Crust., Atlas, 1844?, pl. 51, fig. 2.
Squilla affinis Berthold, Abh. Ges. Wiss. Göttingen, 1845, **3**, p. 26, pl. 3, figs. 1, 2.
Squilla oratoria De Haan in Siebold's Fauna Japonica, Crust., 1849, p. 223.
Squilla nepa Miers, Ann. Mag. Nat. Hist., (5), 1880, **5**, p. 25 (*partim*).
Squilla nepa Brooks, Voy. H. M. S. "Challenger," 1886, **16**, Stomatopoda, p.25.
Squilla affinis Bigelow, Proc. U. S. Nat. Mus., 1894, **17**, p. 538, fig. 22.

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Squilla oratoria Stebbing, Ann. S. African Mus., 1908, **6**, pp. 44, 45.
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Squilla oratoria Kemp, Mem. Indian Mus., 1913, **4**, pp. 66–70, pl. 5, fig. 54–56.
Squilla oratoria Edmondson, P. B. Bishop Mus. Occ. Papers, 1921, **7**, p. 287.
Squilla oratoria Parisi, Atti Soc. Ital. Sci. Nat. (Milano), 1922, **61**, p. 98.
Squilla oratoria Hansen, Siboga-Exped. Monogr., 1926, **35**, p. 11.
Squilla oratoria Komai, Mem. College of Sci. Kyoto Imp. Univ., (B), 1927 **3**, (3), pp. 314–318.

Diagnosis.— A *Squilla* with large triangular eyes, the corneal axis being oblique and as long as, or usually longer, than the peduncular one and about 0.05 times the length of the body — the corneal index (Kemp, 1913, p. 9) varies from 3.8 in small to 6.0 in the largest specimens; anterior margin of ophthalmic somite squarely truncate or emarginate, never pointed; mandibular palp present; raptorial dactylus with six teeth, including the terminal one and its outer margin, distinctly sinuate; dorsal carina of the raptorial carpus bearing two to five tubercles in large specimens, and the inferior margin of the merus produced to a sharp and prominent spine; epipodites present on the first four thoracic limbs; rostrum subquadrate, its sides frequently upturned and convergent, and with a median tubercle; dorsal surface of carapace and abdomen strongly punctate, never polished; five carinae on the carapace, the median one being sharp and distinct throughout its course and bifurcated in front for only about one quarter its length anterior to the cervical groove; the breadth of the carapace behind the antero-lateral angles less than half its length, including the rostrum, lateral carinae continued into the antero-lateral spines, posterior lobes rounded; margins of sixth, seventh and eighth thoracic somites bilobed, the sixth without ventral spine, and having the anterior lobe of the lateral margin parallel-sided and much narrower but scarcely shorter than the posterior lobe; submedian carinae present on all somites, from the seventh thoracic to the sixth abdominal; the following abdominal carinae ending in spines:

Carinae	*Abdominal somites*
Submedian	(4), 5, 6
Intermediate	(1), (2), (3), 4, 5, 6
Lateral	(1), (2), 3, 4, 5, 6
Marginal	1, 2, 3, 4, 5

dorsal crest, ventral keel, and symmetrical lines of pits on surface of telson, six marginal spines, eight basal carinae, denticles — submedian 3–5, intermediate 6–10, lateral 1; inner prong of the basal process of the uropod longer than the other and bearing on its outer edge a small lobe, anterior to which the margin is always strongly concave.

Remarks.— For the sake of uniformity, which I regard as more important than priority, I am following Kemp, Parisi, Hansen, Komai, and others in accepting Stebbing's statement (1908) that the atlas to the Fauna Japonica containing De Haan's figure and name *S. oratoria*, antedates Berthold's paper. Sanborn (1902) does not accept this, but gives 1849 as the date of the name *oratoria* as applied to *Squilla*, whereas the date of *affinis* is 1845. In fact there seems to be no evidence of the date of De Haan's plate. All we have is his own claim of priority (cf. Sanborn, 1902, p. 7). Kemp (1913) states that this species is the most variable in the group to which it belongs. He has set apart as var. *perpensa* the form which occurs on the coast of British India, and which may be distinguished by certain fairly constant characters.

The two specimens in our collection are both of the typical form and are from the Hawaiian Islands. They are like the British Museum specimens from the same region (Kemp, 1913, p. 68) in having only two tubercles on the dorsal margin of the raptorial carpus, in the shape of the rostrum, and in having spines at the ends of the submedian carinae of the fourth abdominal and of the lateral carinae of the first and second abdominal somites. In the larger specimen the intermediate and lateral carinae of all the abdominal somites end in spines, and in this specimen the antero-lateral process of the sixth thoracic somite is shorter than the posterior. In the smaller specimen this feature is typical.

Color.— The color of living examples of this species is probably as variable as in other species of Stomatopoda (e.g. *Gonodactylus*). Fukuda (Komai) (1910) gives a detailed description of the color in life of the Japanese forms. They have brilliant markings of green, red, purple, blue, orange, and black on a grayish ground color, punctate with minute black spots. Edmondson (1921) describes the specimens from Honolulu market as reddish brown with black patches on the uropods, and the dactyli light in color.

Ontogeny.— The breeding season of this species in Japan is from April to July. The female holds the egg cluster in her maxillipeds until the eggs are hatched. Komai (1924) has studied the embryology from the blastula stage to the stage with pigmental eyes, and has studied

also the larval stages (1927). The youngest larvae have a length of 3.5 mm., and the largest is usually about 20 mm., but may reach 57 mm.

Distribution.— This is the commonest stomatopod in Japan (Komai, 1927) where it inhabits the muddy bottoms of bays and inlets. It makes U-shaped tunnels in the mud, one to two inches in diameter, with two entrances one and one-half to two and one-half feet apart.

Our specimens were taken in Hawaii, No. 55 at Honolulu and No. 56 at Hilo. This represents the extreme northeastern point of the range of the species. From there it extends through Japan, Formosa (Komai, 1927) and the Chinese coast to Singapore (Parisi, 1922). The "Siboga" Expedition found a very small specimen (18 mm.) in the southern part of Molo Strait (Hansen, 1926, p. 11) and the Indian Museum has two specimens from Mauritius (Kemp, 1913, p. 68, footnote). On the Chinese coast the range of the typical form overlaps that of var. *perpensa*, which is the only form found on the coast of British India (Kemp, 1913) and in the Philippines (Kemp, 1915).

Use for Food.— This crustacean is one of the objects of fisheries in Tokyo Bay (Komai, 1927), and is offered for sale in the Hawaiian markets (Edmondson, 1921).

Size.— Our specimens are two females, 89 mm. and 176 mm. long Komai records numerous specimens varying from 27 to 182 mm. in length.

Table of Measurements

Specimen	No. 55	No. 56
	mm.	mm.
Total length	176.0	89.0
Carapace length	35.0	19.0
Carapace breadth anterior angles	17.0	10.0
Rostrum length	6.0	3.0
Rostrum breadth	5.0	3.0
Cornea	7.0	5.0
Length thoracic somites	30.0	13.0
Length first to sixth abdominal somite	75.0	37.5
Length telson median line	27.0	14.5

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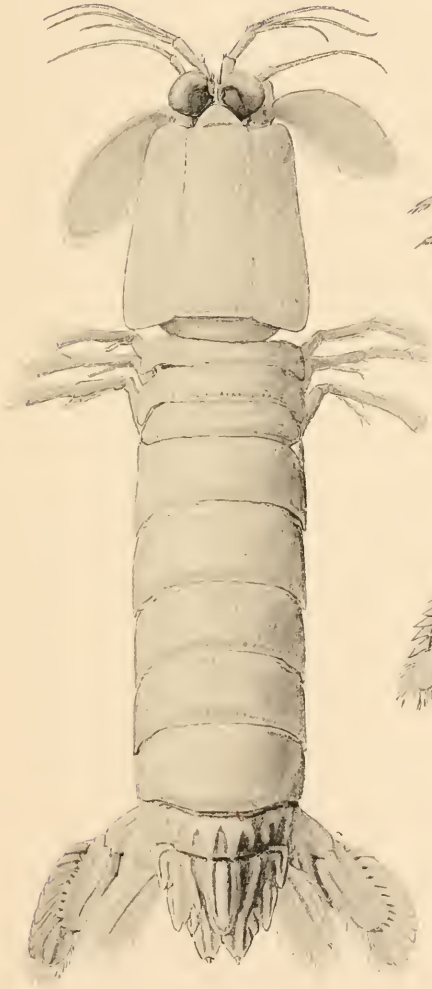
EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Odontodactylus japonicus* (De Haan) male, 115 mm. (No. 20). About life size.

Fig. 2. *Gonodactylus chiragra* var. *platysoma* (Wood Mason), male, 81.5 mm. (No. 13). $\times 1\frac{2}{3}$.



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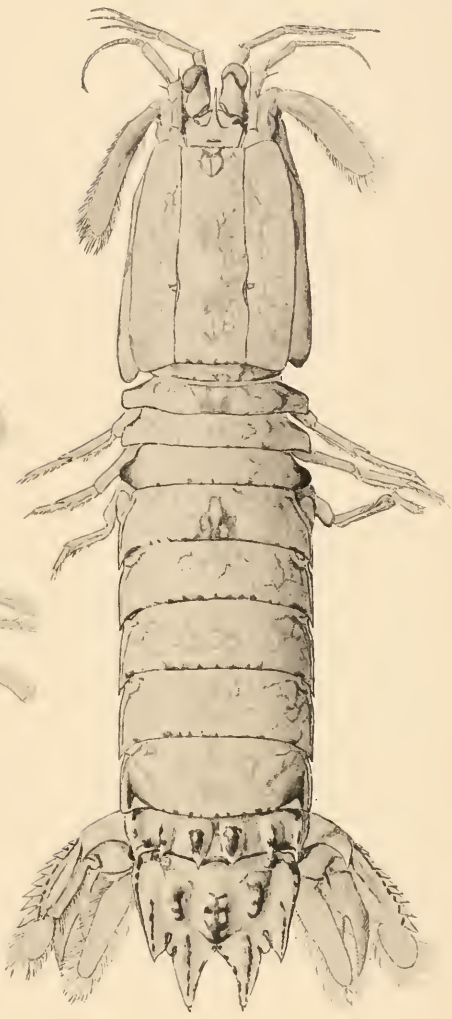
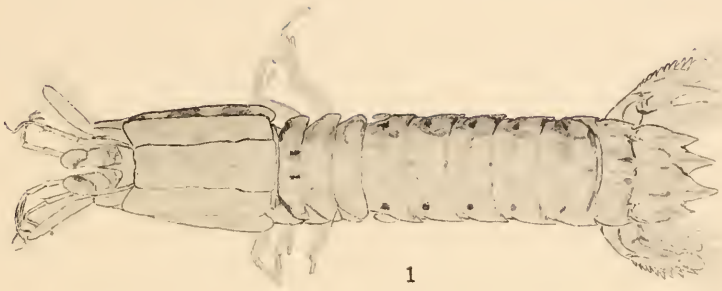


2

PLATE 2

PLATE 2.

Fig. 1. *Gonodactylus chiragra* (Fabricius), male, 46 mm. (No. 9). × $1\frac{2}{3}$.
Fig. 2. *Gonodactylus chiragra* var. *platysoma* female, 70 mm. (No. 14a). × $1\frac{2}{3}$,
Fig. 3. *Gonodactylus oerstedii* var. *festae* (Nobili), female, 33 mm. (No. 54). Sixth abdominal somite and telson, dorsal aspect. × 6.
Fig. 4. Same specimen in lateral view. × $3\frac{1}{3}$.



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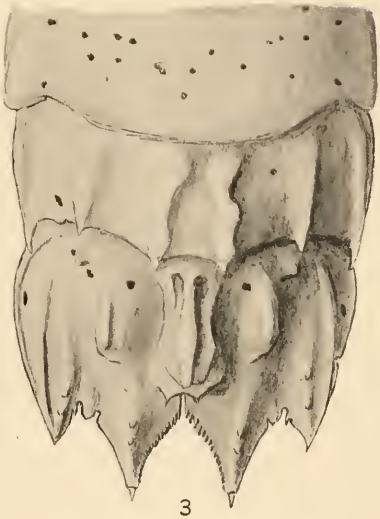

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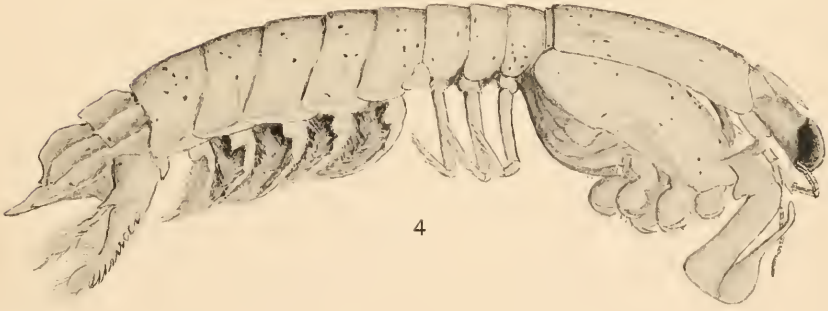

4

Bulletin of the Museum of Comparative Zoölogy
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THE KILN SHALE FAUNA

BY C. H. BURGESS

WITH ONE PLATE.

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No. 5.— *The Kiln Shale Fauna*

By C. H. Burgess

Introduction

The fossils here considered were collected in the summer of 1929 as part of the work done in the Harvard Summer School of Field Geology, which was conducted in Jasper Park, Alberta. They were found in concretions scattered through a black fissile shale, the Kiln formation, at an outcrop three miles south of Pocahontas on the eastern side of the Athabaska River (for the stratigraphic relations of this formation, see Raymond, 1930, p. 296).

The writer wishes to acknowledge the generous help of Professor P. E. Raymond, under whose tutelage this paper has been prepared.

Correlation

The fauna is related to that of certain shales in the Mackenzie River Valley, the Three Forks shale of Montana, and the Naples of New York.

The first indication of this type of fauna appears in the Coronach black shale, some 300 feet below the Kiln formation, in the presence of *Posidonia* cf. *P. attica* (Williams) and *Ontaria* cf. *O. halli* Clarke, in the Roche Miette section (Raymond, 1930, p. 296) and *Ontaria sp.* Ind., *Pterochaenia* cf. *P. fragilis* (Hall), and *Bactrites* cf. *B. aciculum* Hall, in the section near Snaring Junction (*idem.*, p. 297).

This fauna is like one of Portage age described by Kindle (1919) from the Mackenzie River Valley, in the presence of *Buchiola retrostriata* (von Buch), *Entomis variostriata* Clarke, *Styliolina fissurella* (Hall), and representatives of the genera Tentaculites and Baetrites.

Another similarity is the paucity of brachiopods, only one, *Cyrtina glabra* Kindle, having been found in the Mackenzie region, while the Kiln shale collection shows only a few Lingulas and a Leiorhynchus. *Buchiola retrostriata* (von Buch) is the commonest fossil in both regions, with the exception of *Styliolina fissurella* Hall, in the Kiln formation.

Kindle (op. cit.) found *Ontario clarkei* (Beushausen), *Paraptyx* cf. *ontario* Clarke, *Paracardium doris* Hall, and *Entomis serratostriata* Sandberger, all of which are characteristic of the Naples section. They

do not appear in the Kiln shale. Likewise his new species *Cyrtina glabra*, *Buchiola dilata*, and *Tentaculites mackenziensis* are absent. Kiln shale fossils not found in the Mackenzie region are *Euthydesma subtextile* Hall, *Tentaculites scalaraformis* Hall, *T annulatus* Schlotheim, *Entomis nodosa* n. sp., *Praecardium laticostatum* n. sp., *Lingula melie* Hall, *Leiorhynchus athabascense* n. sp., *Tornoceras bicostatum* Hall, and *Bactrites gracilior* Clarke.

Bactrites and Tentaculites occur at both localities, but in different species.

The only link with the Three Forks fauna is the presence of Tornoceras and Bactrites, (Raymond, 1909, p. 152), and of Entomis and Leiorhynchus (Raymond, 1907, pp. 118, 119).

All the Kiln shale genera are to be found in the New York section, although the species of Lingula, Leiorhynchus, Praecardium, and Tentaculites are not the same in the two regions (Clarke, 1904). The forms common to both localities are *Buchiola retrostriata* (von Buch), *B. conversa* Clarke, *B. scabrosa* Clarke, *Euthydesma subtextile* Hall, *Styliolina fissurella* (Hall), *Tornoceras bicostatum* Hall, *Bactrites gracilior* Clarke, and *Entomis variostriata*.

On the basis of community of genera and species, the Kiln fauna seems more like the Naples fauna of New York than that of the Three Forks shale of Montana. The stratigraphic position of the Kiln shale, however, 2500 feet above the Perdrix shale, which is shown by the presence of *Manticoceras* sp. ind. to be Middle Upper Devonian (Raymond, 1930, p. 298) indicates that the Kiln is highest Upper Devonian, and thus equivalent to the Three Forks shale.

In the Jasper section the *Spirifer whitneyi* fauna occurs in the Boule formation, and also in the overlying Coronach. Three hundred feet of Fiddle limestone follow, then the Kiln shale.

Further north in Canada, in the Mackenzie Valley, Kindle (1919, p. 2) found the *Buchiola retrostriata* fauna in shales beneath limestone containing the *Spirifer disjunctus* assemblage just as in New York. If *Spirifer whitneyi* and *S. disjunctus* characterize strata of the same age, the situation in Jasper Park is anomalous, the fossils appearing in reverse order.

It seems, therefore, that the Portage fauna survived longer in the Jasper region than in the Mackenzie district. In the latter it died out when the *Spirifer disjunctus* fauna came in, but in the more southern region, where conditions were more favorable to the deposition of great thicknesses of shale, it persisted longer than the *Spirifer whitneyi* fauna.

Description of the Fauna

BRACHIOPODA

Lingula melie Hall

Hall, Palaeontology of New York, 4, 1867, p. 14, pl. 1.

The concentric striae of this form are present, but the coarser radiating striae are not.

Leiorhynchus athabascense spec. nov.

Outline similar to that of *L. mesacostalis* Hall, but the posterior margin makes a slightly more obtuse angle at the beak. Both valves are moderately convex. The eight broad plications, generally well marked on the anterior half of the shell, become obsolescent toward the beak, so as to leave the posterior third of the shell smooth.

The fold, which is of the same length as the longest plications, has a conspicuous sinus. A small ridge extends the length of this sinus, almost to the beak. There is a broad convex ridge in the sinus of the pedicle valve.

PELECYPODA

Buchiola retrostriata (V. Buch)

Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 295, pl. 10, figs. 1–14.

The specimens at hand show no points of difference from those in the New York beds. The number of plications is usually twelve. The sulci and the characteristic retrally curved ridges on the summits of the ribs are just the same as in the fauna described by Clarke.

This is the most abundant species in the fauna, with the exception of *Styliolina fissurella* (Hall).

Buchiola conversa Clarke

Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 295, pl. 10, fig. 22.

The flat-topped ribs which become concave toward the periphery are characteristic of this form. On the anterior and posterior slopes of the valves, the ribs are less distinct, and may be absent in the umbonal region.

Buchiosa scabrosa Clarke

Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 229, pl. 10, figs. 25–28.

One specimen shows the coarse retral ridges on the ribs over the umbonal region, which become fine and crowded on the ventral half of the shell. Clarke does not state whether this change in ornamentation is abrupt, or whether there is a zone of blending of the two types of ridges. The figures seem to indicate the latter. In the Jasper form, however, the change is abrupt, with no intermediate types of cross ridges. This change occurs at the same distance from the beak on all the ribs.

Euthydesma subtextile Hall

Hall, Palaeontology of New York, V, Lamellibranchiata, II, 1885, p. 385, pl. 63, figs. 11–16; pl. 93, figs. 28, 29.

Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 292, pl. 9, figs. 8–17.

The only specimen, a left valve, is incomplete in the absence of the distal portion of the sub-alate cardinal expansion, but can be reconstructed with fair accuracy by means of the concentric growth lines. So reconstructed, the shell does not differ materially in outline from the New York specimens figured by Hall. The concentric striae are conspicuous over the entire shell; fine striae radiating from the beak to the margin can be seen only under a lense.

The shell is very small, being only 10 mm. in height, whereas the New York specimens measure between 30 and 40 mm.

Praecardium laticostatum spec. nov.

One specimen, a right valve. Shell strongly convex, with high beak. Anterior lateral expansion steeper and less broad than posterior. There are fourteen strong radiating ribs. In other species, the ribs are less broad than the intervening sulci, but in this form the ribs are the larger. The bottoms of the grooves are more strongly curved than the tops of the ribs, although the latter are not flat, as in some species. The ribs show a tendency to rugosity, giving a rather lumpy appearance. At no place on the shell are the sulci wider than the ribs, and both increase in size as they approach the margin of the shell, the

coarsest of the ribs being about twice the size of the intervening troughs. The height of the shell is 3.7 mm. For revisions of this genus cf.

Barrande, Système Silurien de la Bohême, **6**, Texte I, 1881, p. 141–44, pls. 87–97; 285, 359, 360.

Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 305.

TUBICOLA ?

Tentaculites scalariformis Hall

Hall, Palaeontology of New York, **5**, pt. 2, 1879, p. 167, pl. 31, figs. 3–11.

The single specimen shows conspicuous annulations, from the crest of which the slope of the surface to the main line of the shell is less steep in the direction toward the apex than toward the apertural end. The shell is deformed close to the apex, so no accurate measurement could be made.

Tentaculites annulatus Schlotheim

Schlotheim, Die Petrefactenkunde, 1820, p. 377, pl. 29, fig. 8, a and b.
Dunker & Meyer, Palaeontographica, **3**, pt. 1, 1850, p. 21; pl. 3, fig. 36.

The original figure of this form by Schlotheim is so poor as to be of no assistance in identification. The one pyritized specimen does agree with the illustrations and description by Dunker and Meyer.

Sixteen annulations have been preserved. The sides of the annulations closer to the apex slope away from the main line of the shell at a rather steep angle; the other ribs are perpendicular to the general line of the shell. Length, 1.2 mm.

PTEROPODA

Styliolina fissurella (Hall)

Hall, Palaeontology of New York, **5**, pt. 2, 1879, p. 178, pl. 31A, figs. 1–30.

This is the most abundant fossil in the fauna. The Jasper specimens range from .5 mm. to 1 mm. in length, while those in the Styliolina layer of the Genesee shale of New York range from 1 mm. to 2.5 and 3 mm.

CEPHALOPODA

Tornoceras bicostatum Hall

Clarke, The Naples Fauna in Western New York, pt. 1, 16th Ann. Rept. State Geol., 1898, 1899, p. 118, pl. 8, figs. 4–13.
Hall, Palaeontology of New York, **5**, pt. 2, 1879, p. 450, pl. 72.

Two specimens show almost complete closure of the umbilicus. The surface markings radiate from the umbilicus in weak curves, the degree of curvature of these growth lines changes; and at the margin, the lines tend to parallel the periphery.

In contrast with the other members of the fauna this form is of normal size compared with the New York specimens. Clarke states that "at maturity the species seems seldom to surpass a diameter of 25 mm." The larger of the two specimens at hand is 27 mm.

Bactrites gracilior Clarke

Clarke, The Naples Fauna in Western New York, pt. 1, 16th Ann. Rept. State Geol., p. 124, pl. 9, figs. 1–16, 1898 (1899).

The shells have collapsed longitudinally, giving the appearance of two small individuals lying side by side. The form of the shell and the character of the markings differ in no respect from those of the New York specimens.

Crustacea

OSTRACODA

Entomis variostriata Clarke

Kindle, Canada Department of Mines, Geological Survey. Mus. Bull. 29, Geol. Series 36, 1919, p. 7, pl. 2, figs. 1–3.
Clarke, Naples Fauna in Western New York, pt. 2, Mem. VI, N. Y. State Mus., 1904, p. 344, fig. 13.

The specimens show the concentric sculpture characteristic of this form; the reticulation is very fine.

Entomis nodosa spec. nov.

The shell is moderately convex, and ovate in outline; the sulcus well defined from the dorsal margin to the small muscle pit at the top of the valve; from that spot to the ventral margin it is less distinct.

The reticulation does not follow any definite geometric pattern, but toward the edge of the valve suggests lines parallel to the margin

Small nodes are scattered over shell, with or without definite geometric arrangement. On the anterior end of one specimen there are four distinct nodes in a row running transversely across the shell, half as far from the end of the valve as from the sulcus. There is a row of three knobs parallel to the dorsal margin, the middle knob being also the terminal node of the above described row. Another pustule is situated slightly behind and ventrad to the pit which lies in the sulcus at the top of the valve. One other node rises above the surface slightly behind the sulcus and at about one-third of the distance from the dorsal edge to the antero-posterior median line of the valve.

In another specimen the small nodes are scattered over the anterior two-thirds of the valve, seemingly without definite pattern, except for a row analogous to that in the specimen described above; in the second specimen, however, this row is on the posterior end.

The largest specimen is 2.3 mm. long, and 1.6 mm. wide across the sulcus.

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EXPLANATION OF PLATE

EXPLANATION OF PLATE

Fig. 1. *Entomis nodosa* spec. nov.
Left valve. × about 10.

Fig. 2. *Leiorhynchus athabascense* spec. nov.
Brachial view, showing low ridge in conspicuous sinus of fold. × about 3.5.

Fig. 3. *Praecardium laticostatum* spec. nov.
Right valve. × about 7.5.

Photographs by F. P. Orchard

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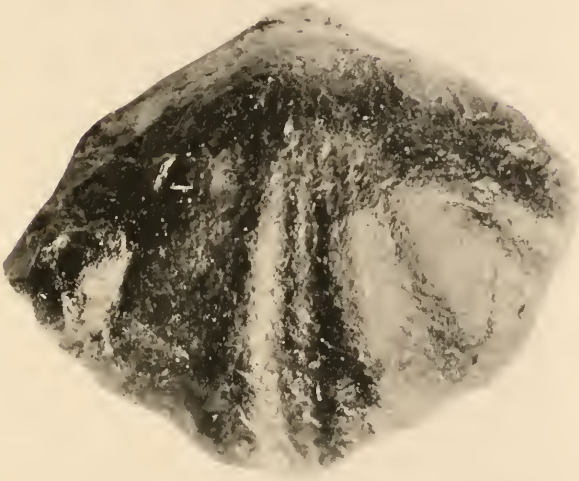

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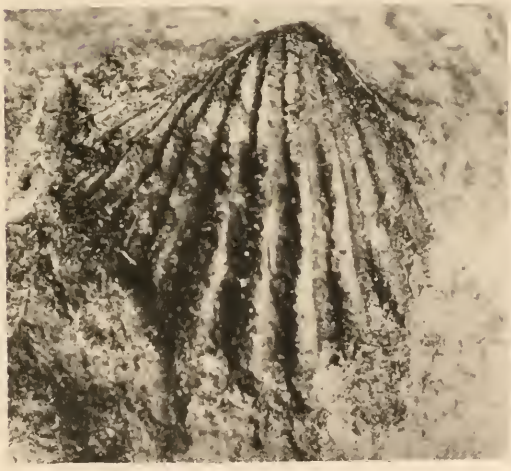

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REVISION OF THE NEARCTIC MECOPTERA

BY F. M. CARPENTER

WITH EIGHT PLATES

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No. 6.— *Revision of the Nearctic Mecoptera*

By F. M. Carpenter

The Mecoptera, or scorpion-flies, occupy a small corner of the present insect world, including only about two hundred species. In common with other inconspicuous insects they have received little attention from entomologists generally, and they are sparsely represented in most collections. The present revision was started several years ago at the suggestion of Nathan Banks with the intention of placing the Nearctic species on a firmer and more modern taxonomic basis, and with the hope that the publication of such a work would arouse some interest in these insects, resulting in the collection of further specimens or in the addition of observations on their biology.

Through the courtesy of many entomologists I have been enabled to examine over six thousand specimens of Nearctic Mecoptera, of which about four-fifths belong to Panorpa. To these collectors and the institutions with which they are associated, I am grateful for the kind coöperation which has made this study possible: Professor J. C. Bradley, Cornell University; Dr. W. E. Britton, Connecticut Agricultural Experiment Station; Professor C. T. Brues, Harvard University; C. S. Brimley, North Carolina Department of Agriculture; A. N. Caudell, United States National Museum; Dr. G. C. Crampton, Massachusetts Agricultural College; J. E. Davis, Alsea, Oregon; W. T. Davis, Staten Island, New York; G. P. Engelhardt, Brooklyn Museum; Professor F. W. Fattig, Emory University, Georgia; Professor T. H. Frison, Illinois State Natural History Survey; Dr. F. M. Gaige, University of Michigan; W. J. Gerhard, Field Museum, Chicago; Dr. Hugh Glasgow, New York State Museum; Professor H. G. Good, Polytechnic Institute, Auburn, Alabama; C. W. Johnson, Boston Society of Natural History; Dr. J. I. Kendall, Sterlington, New York; Professor C. E. Mickel, University of Minnesota; A. P. Morse, Peabody Museum, Salem, Mass.; Professor Franklin Sherman, Clemson College, South Carolina; Professor R. C. Smith, Kansas State Agricultural College; E. P. Van Duzee, California Academy of Sciences; and Professor W. M. Wheeler, Harvard University. I am especially indebted to the authorities of the United States National Museum for the privilege of studying the type of *Panorpa latipennis* Hine, and to Dr. H. Eltringham of the British Museum of Natural History, and Dr. A. Ball of the Natural History Museum of Brussels, for careful drawings

and descriptions of the types of our Panorpas in their institutions. To Nathan Banks I owe many thanks, not only for his helpful advice, but for the suggestion of an investigation which has proved so interesting.

This material has enabled me to examine representative collections from fifteen Atlantic states, as well as Minnesota, Michigan and Texas. From several other states, mostly central, I have been able to obtain only a few scattered records, and I have no records at all from Iowa and Kentucky, although both Panorpa and Bittacus undoubtedly occur there. This scarcity of records in the central states is very regrettable, for most of the Panorpas of this area are distinctly different from those of the east. The Rocky Mountain states are apparently without any Mecoptera, but the Pacific states and even Alaska have a few species of Bittacus or Boreus. Numerous specimens of the latter genera have been sent to me in collections of miscellaneous Mecoptera.

Four of the five existing families of Mecoptera inhabit North America, namely, Meropidae, Panorpidae, Bittacidae, and Boreidae; the fifth family, Notiothaumidae, is monospecific and restricted to Chile. The family Meropidae is represented by a single species occupying the eastern United States. The Panorpidae is the largest family and is widely distributed over nearly the entire Holarctic region and parts of the tropics. The Bittacidae is a smaller group, but it has the greatest dispersal of all, inhabiting temperate and tropical areas in both hemispheres. The Boreidae is an even smaller family, with less than a dozen species; it is restricted to parts of North America and Europe. The first of our American Mecoptera were described in 1787, when Swederus published accounts of two Panorpas, *americana* and *lugubris*. During the nineteenth century twenty-two more species were described from the United States, mostly by European entomologists (Westwood, Rambur, Say, Newman, etc.). Since 1900 Banks, Hine, and Esben-Petersen have brought this number to thirty-five. In the collections which I have examined, twenty additional species have been found, making the total number of described species fifty-four; and there are undoubtedly several unknown Panorpas in the central states.

The North American families can be recognized as follows:

1. Tarsi raptorial, with a single claw.....Bittacidae
   Tarsi normal, with two claws.....2
2. Flightless species, the wings without veins and reduced to thick projections (♂) or small oval pads (♀); female with long ovipositor.....Boreidae

Flying species, with perfect wings; or flightless females, with small, normally shaped wings, containing a complete set of veins; female without an ovipositor.....3

3. Wings oval; venation dense, with numerous crossveins; ocelli absent ..... Meropidae

Wings slender; venation reduced, with few crossveins; ocelli present. Panorpidae

MEROPIDAE

Ocelli absent; labial palpi two-segmented; female without ovipositor; male with a pair of elongate, two-segmented genital claspers. Fore wing: costal space broad, traversed by numerous irregular veinlets; Sc terminating only a little basad of the pterostigma; Rs usually with 5 branches, only R2 forked; M with 5 branches, only M4 forked; Cu1 and Cu2 simple; 2 anals present. Hind wing: venation similar to that of fore wing; costal space not so broad; Rs with 5 branches, either R2 or R3 being forked; Cu1 fused with M basally; Cu2 fused with 1A basally.

Merope Newman

Merope Newman, 1838, Ent. Mag., **5**, p. 180. Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 194. Hagen, 1861, Syn. Neurop. N. A., p. 248.

Rostrum short, narrowed apically; eyes reniform, nearly contiguous dorsally; antennae short, broadest at middle; fore wing with a thick, lunate lobe, covered with hairs, on the posterior margin at the base; hind wing with a similar but smaller lobe; tarsal claws smooth.

Genotype.— *Merope tuber* Newman.

Merope tuber Newman

Text-fig. 1

Merope tuber Newman, 1838, Ent. Mag., **5**, p. 180. Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 194; pl. 14, fig. 2. Hagen, 1861, Syn. Neurop. N. A., p. 248. Fitch, 1872, Trans. N. Y. State Agric. Soc., 1870, pp. 373–381. Hine, 1901, Bull. Sci. Lab. Denison Univ., **11** (10), p. 263. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 105; pl. 2, fig. 20.

Length of fore wing, 10–14 mm.; width, 4–6 mm. Head, body and legs nearly uniformly luteus; rostrum and especially pronotum darker; antennae brown at middle; wings usually smoky, sometimes nearly colorless; legs short. Female slightly smaller than the male. The

peculiar genital claspers of the male have been completely described and figured by several investigators and need not be discussed further here (see Muir, 1921).

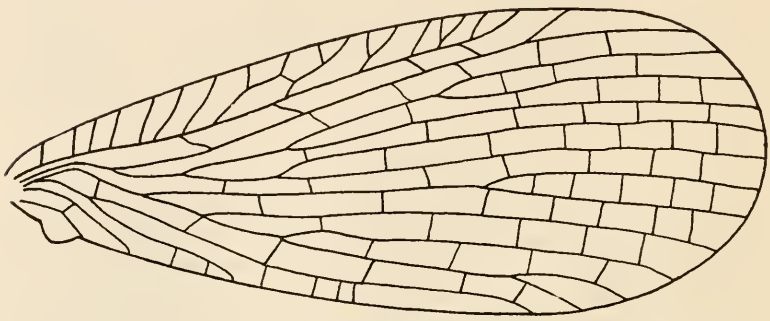

Fig. 1— Fore wing of *Merope tuber* Newman

Holotype (♀).— Trenton Falls, New Jersey (F. Doubleday); in British Museum.

Allotype (♂) by present designation.— Sullivan Co., New Jersey, August; in Museum of Comparative Zoölogy.

This insect is probably the rarest of all our Mecoptera inhabiting an equivalent area. It has been found at several scattered localities in the eastern states, ranging from Orono, Maine, to Raburn Co., Georgia. The North Carolina and Georgia specimens were taken in early July; the more northern ones, from late July to early September. Because of its rarity and peculiar appearance Merope has been the subject of several short notes (Johnson, 1913; Barber, 1903). It appears to be rather strongly phototropic; at least, more specimens have been taken at lights or in light traps at night, than during the day. None of the other Mecoptera, except perhaps some species of Bittacus, have shown a similar tropistic reaction. Newman's type was a female and the male was unknown until 1861, when Hagen obtained a specimen from Pennsylvania. This sex has been frequently described in recent years, but no specimen designated as allotype.

At the present time, *tuber* is the only known member of the family Meropidae. Tillyard has placed the peculiar *Notiothauma reedi* in this family also, but the great difference in genital structure does not justify this. In venation, however, Merope and Notiothauma stand as the most primitive of existing Mecoptera. In common with other primitive types of insects, Merope has an excessively variable venation. No two specimens which I have seen agree in the relationship of the

veins at the bases of the wings. In some specimens, for example, 1A of the hind wing does not fuse with Cu2 until very close to the base of the wing, while in others this coalescence takes place near the termination of 1A. The branching of most of the veins is constant, but in about half the specimens which I have seen, both M4a and M4b are simple; in the others, one of these is forked; more rarely, M3 or M2a is forked. All these variations may occur in the right and left wings of the same specimen.

PANORPIDAE

Ocelli present; labial palpi two-segmented; abdomen cylindrical or nearly so, tapering to a point in the female, without ovipositor; apical segments of male modified, usually enlarged; two tarsal claws; wings usually slender, with primitive venation; costal space narrow, with few crossveins; Rs originating at about one-third of wing length from base; M dividing near the middle of wing.

Two genera of this family occur in North America; they are distinguished as follows:

Rostrum very short; genae with prominent teeth.
Brachypanorpa, new genus

Rostrum long and slender; genae without teeth ..... *Panorpa*

Brachypanorpa, new genus

Allied to Panorpodes. Rostrum very short in both sexes; maxillary palpi tubular; labrum with a slight incision at apex; genae with projecting teeth, much larger in the female than in the male; tarsal claws smooth, curved; abdomen of male short, the seventh and eighth segments as broad but no longer than the basal ones; hypovalvae diverging at about the center of the genital bulb; forceps with a large inner tooth at the base; venation of male similar to that of Panorpa or Panorpodes. The female is flightless, the wings small, not reaching the end of the abdomen; the media has three branches; the head is broader than in the male.

Genotype.— Panorpodes carolinensis Banks.

This genus is erected for three closely related American species, *oregonensis* MacLachlen and *carolinensis* Banks, which have formerly been placed in Panorpodes, and a new species, *montana*. Panorpodes was originally established by MacLachlan (1875) for the Japanese *paradoxa*, and now includes three other Japanese species. Panorpodes is easily distinguished from Panorpa by the simple tarsal claws, the

shorter rostrum, the flattened maxillary palpi, and especially the form of the seventh and eighth abdominal segments of the male, which are of ordinary shape, not modified as in Panorpa. In 1881 MacLachlan described the male of a scorpion fly from Mt. Hood, Oregon, which he called *oregonensis* and placed tentatively in the genus *Panorpodes*. He observed that in this species the rostrum was much shorter than in *paradoxa*, that the maxillary palpi were tubular, and the genae were produced downward into triangular teeth. He concluded his description with the remark that "it may ultimately be considered necessary to transfer *P. oregonensis* to a distinct genus." In 1905 Banks described a similar male from the Black Mountains of North Carolina, which he called *Panorpodes carolinensis*. Several years later he succeeded in finding the females of this insect, and although he did not describe them in detail, he mentioned (1911) that they were "very short winged and unable to fly, but hop about very lively when one attempts to capture them." The female of *oregonensis* has never been described.

In the collections of Mecoptera which I have examined, I have seen numerous specimens of *carolinensis* and *oregonensis*, as well as several representatives of a new, related species. A comparison of these with the Japanese *Panorpodes paradoxa* and its relatives convinces me that the American forms, as MacLachlan suspected, should be removed from Panorpodes. The rostra of our species are much shorter than those of the Japanese insects; in fact one might truthfully state that they are not beaks at all, whereas in the Japanese species the beak is only a little shorter than in Panorpa. In respect to the length of the rostrum, *oregonensis*, *carolinensis*, and *montana* are unique among the other Mecoptera of the world. An additional feature, unknown to MacLachlan, of course, is the flightless condition of the females, for this sex has reduced wings in *oregonensis* as well as *carolinensis*. In both these species also the head is broader in the female than in the male, and the teeth on the genae are much larger. This sexual dimorphism, together with the short rostrum and the other characteristics mentioned above, are certainly of generic significance.

Unfortunately, nothing is known of the life history or feeding habits of these insects. The species can be recognized as follows:

1. Ocellar bristles absent (North Carolina) ..... *carolinensis* Banks
   Ocellar bristles present (western United States) 2
2. Antennae black; genital forceps blunt; fore wing (♂) 13–15 mm. long ..... *montana*, n. sp.
   Antennae brown; genital forceps pointed; fore wing (♂) 9–10 mm. long ..... *oregonensis* MacL.

Brachypanorpa carolinensis (Banks)

Figs. 1, 2, 3

Panorpodes carolinensis Banks, 1905, Bull. Amer. Mus. Nat. Hist., **21**, p. 215. Banks, 1911, Trans. Ent. Soc. Amer., **37** (4), p. 349. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 96, fig. 107.

Male.— Body light brown, legs and antennae darker; genital bulb rounded; hypovalvae fused for half their lengths; teeth of forceps directed downward; rostrum broad, apical incision shallow; no ocellar spines. Fore wing: length, 10–11 mm.; width, 3 mm.; membrane uniformly light brown, with a greasy appearance.

Female.— Color similar to that of the male; wings not quite reaching the end of the abdomen; length of fore wing, 5–6 mm.; width, 1 mm.; wing veins with short, inconspicuous hairs.

Cotypes (♂).— Two specimens in Museum of Comparative Zoölogy and five specimens in American Museum of Natural History; all from the Black Mts., North Carolina.

Allotype (♀) by present designation.— In Museum of Comparative Zoölogy, from Black Mts., North Carolina, June (N. Banks).

This insect is common in the vicinity of Black Mt., where a number of specimens have been taken by Banks and Beutenmüller, during late May and early June. In the collection of the North Carolina Department of Agriculture (Raleigh) there are also specimens from Linville Falls, late May and early June (F. Sherman); Mt. Mitchell, at 6,700 ft., July 18 (R. W. Leiby); Craggy Mt., June 6 (R. W. Leiby); Swannanoa, June 22 (R. W. Leiby). The species is apparently restricted to a small area, the greatest diameter of which is under forty miles. It is interesting to note that all the localities at which it has been taken are at high altitudes, ranging from the top of Mt. Mitchell (6,700 ft.) to Swannanoa (2,500 ft.). Undoubtedly the distribution of the insect is limited by the flightless condition of the females; but it is curious that the other two species of the genus are confined to another small section of the country, over two thousand miles distant.

Brachypanorpa oregonensis (MacLachlan)

Fig. 4

Panorpodes oregonensis MacLachlan, 1881, Ent. Mo. Mag., **18**, p. 37, fig. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 96, fig. 106.

Male.— Body dark brown; 4 long ocellar spines; genital bulb slender; hypovalvae fused for more than half their lengths; teeth of forceps pointed inward, rather than downward. Fore wing: length, 10–11 mm.; width, 3 mm.; membrane uniformly light brown, with a greasy appearance.

Female.— Color similar to that of male. Length of fore wing, 1.8 mm.; width, .2 mm.; wings not reaching beyond the first segment of the abdomen; both pairs of wings bordered by long hairs, and bearing similar hairs on the longitudinal veins, especially R and M.

Cotypes (♂).— Mt. Hood, Oregon; in MacLachlan collection.

Allotype (♀) by present designation.— Mary's Peak, Oregon, at 5,000 ft., July 10 (Mrs. Griffin); in Museum of Comparative Zoölogy.

I have seen thirty-two specimens of this remarkable species. In the Illinois Natural History Survey collection there are two males from Mary's Peak, June 30, 1896 (G. F. Moznette); in the Museum of Comparative Zoölogy there are three males from the same locality (July 10, Mrs. Griffin). In the United States National Museum there are three males from Walport, Oregon (April 22, 1926, J. E. Davis) and one from Crater Lake National Park (August 4, 1915, 7,000 ft., J. E. Davis). In the writer's collection there is one male from Mary's Peak (Mrs. Griffin); fourteen males from Walport (June 22, 1930), and two others from the same locality (May 9, 1926); one from Triangle Lake, Oregon (May 24, 1925, H. A. Scullen); two from Pamelia Lake, Oregon (July 27, 1927, 3,000 ft., J. C. Bridwell); and two females from Walport, (June 22, 1930, J. E. Davis). The individuals from Walport, Triangle Lake, and Pamelia Lake have slightly darker wings than the others, with the cells of the wings more or less shaded. The degree of shading varies greatly in these specimens, however, and some individuals from Mary's Peak show a faint trace of similar markings. Since the male genitalia of all these forms are identical, I am convinced that we are dealing with a single species.

The male of *oregonensis* is very much like that of *carolinensis*, but the presence or absence of the ocellar spines would enable easy recognition even if the ranges of the two species overlapped. The females are very different, the wings of *oregonensis* being less than half the size of those of *carolinensis*. It is interesting that the venation is no more reduced in the former species than it is in the latter, regardless of the diminished size of the wings.

Brachypanorpa montana, n. sp.

Male.— Body dark brown, antennae black throughout, wings brown to very dark brown; 4 ocellar spines; genital bulb slender; hypovalvae not so long as the rest of the hypandrium, not reaching the bases of the forceps; teeth of forceps pointed inward. Fore wing: length, 13–15 mm.; width, 4–5 mm.

Holotype (♂).— Mt. McLaughlin, Klamath Co., Oregon, at 8–9,000 ft., July 19, 1930 (H. A. Scullen); in the Museum of Comparative Zoölogy.

Paratypes (♂).— Two in the Museum of Comparative Zoölogy, four in the collection of J. E. Davis, and two in the writer's collection; all from the type locality, July 19 (H. A. Scullen).

All the above specimens were sent to me by Mr. Davis, who recognized the species as a new one and kindly consented to my including the description in this revision. *Montana* is close to *oregonensis*, but can be distinguished by its larger size, darker wings, black antennae, and shorter genital forceps. Judging from the type locality, it occurs at higher altitudes than *oregonensis*. Mr. Davis tells me that he has seen a specimen of this species from Coolin, Idaho (July 15, 1927, E. C. Van Dyke), and another from Prospect, Oregon (June 20–24, C. L. Fox), both in the collection of the California Academy of Sciences.

Panorpa Linné

Panorpa Linné, 1758, Syst. Nat., **10**, p. 551. Klug, 1836, Abh. Königl. Akad. Wiss. Berl., 1836, p. 88. Rambur, 1842, Hist. Nat. Ins. Neyropt., p. 328. Westwood, 1846, Trans. Ent. Soc. Lond., **4**, pp. 184–197. Miyaké, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, **4**, p. 335. Esben-Petersen, 1921, Col. Zoöl. Selys Longchamps, **5** (2), p. 13.

Aulops Enderlein, 1910, Zoöl. Anz., **35**, p. 390.

Estenella Navas, 1912, Rev. Russe d'Ent., **12**, p. 356.

Rostrum long and slender; maxillary palpi tubular; apical margin of palpi entire; genae without teeth; tarsal claws serrated on inner margins; sixth, seventh, and eighth abdominal segments of male modified; Sc terminating on costal margin; R2 usually forked; 1A long, extending beyond origin of Rs; three anal veins. The wings are fully developed in both sexes.

Genotype.— Panorpa communis Linné.

This is the largest genus of Mecoptera, containing upwards of 130 species. It is generally distributed over the holarctic regions but in North America it is restricted to the eastern half of the continent. So far as Canada and the United States are concerned the western limit seems to be approximately along longitude 95°, although one species (*nuptialis*) has been taken as far west as Austin, Texas (about 98°). In Mexico the genus goes a little farther to the west, to the town of Tepic (about 105°). Panorpa does not extend very far into Canada; I have seen no specimens taken north of latitude 50°. The species are most numerous between 35° and 45° latitude.

Regardless of the large size of the genus and the local abundance of certain species, little is known of their habits. Only one investigator in this country, Dr. E. P. Felt, has successfully studied their life history, so our knowledge of their biology has largely resulted from observations made in other countries. The earlier writers thought that the Panorpidae were exclusively predaceous and this view has persisted until within very recent years. Lyonnet started this notion in 1742, in Lesser's "Theologie des Insectes," where he states that he saw a fly of the size and appearance of a scorpion-fly attack a damsel-fly ten times its size and bring it to the ground. The Odonatan was unable to repel its agressor and would have perished from the repeated thrusts of the "scorpion-fly's" beak had not Lyonnet interfered. Kirby and Spence describe this encounter in the fifth edition of their "Introduction," and state without reserve that the offending insect was *Panorpa communis*, although there was certainly no evidence for this conclusion; and in view of the more recent observations, it seems clear that this "tyrant of insect creation" was not a Mecopteron. Brauer (1863) fed adult Panorpas on bits of meat and on insects which had just been killed. In the "Feuille des jeunes naturalistes" for 1880 there appeared an anonymous note describing several specimens of *Panorpa communis*, which were eating portions of fish that had been placed upon a bank near a stream. Felt (1894) fed adults of one American species, probably *P. canadensis* Banks, on injured lepidopterous larvae, and he was also able to keep one female alive for eighteen days on a diet of fresh meat. Poulton saw several European species of Panorpa feeding on other arthropods, but the latter were dead when he first examined them. Lucas (1910) mentions an adult which was feeding on a "whitish grub." Campion (1912) concluded from several experiments on *P. communis* and *P. germanica* that they feed on dead or nearly dead animal matter. Miyaké (1912) was convinced from his extensive observations that the food of Panorpa usually consists of dead or injured insects, although he saw one female attack a living and healthy larva of its own species. Shiperovitsh (1925) states that all the investigations on the subject prove that the adult Panorpas are exclusively saprophagous. However, if so used, the term "saprophagous" must be very broadly understood, for the injured insects and fresh meat used above could hardly have started to decay by the time they were devoured by the Panorpas. Also, it must be remembered that the adults have been seen feeding on the nectar of flowers, and Miyaké records seeing several specimens feeding on the petals of sweet william (*Silene armeria* Linné); in every case the entire petal was affected and later wilted. The sum of these

observations suggests that the various species or species groups of the genus have diverse sources of food.

The life history of Panorpa was first partly investigated by Maquart (1831), who very briefly described the pupa, and by Stein (1838, who gave the first figure of the pupa. Brauer (1863) was the first to work out the life history completely, basing his studies on three European species, *P. variabilis, montana*, and *communis*. Some of the larvae and pupae which he reared are now in the Museum of Comparative Zoölogy. Felt (1896) succeeded in rearing the larva of a Panorpa at Ithaca, N. Y., and his account is the only one published on the life history of an American species.[1] The most extensive studies of Panorpa have been carried out by Miyaké (1912) on the Japanese *P. klugi*. More recently, Shiperovitsh has studied the life history of *P. communis* and *cognata*. The following account of the development of Panorpa is based upon these observations, supplemented by a few observations of my own on *maculosa* Hagen.

The eggs are spherical or oval, white or yellow, or even orange. They vary somewhat in size, depending on the dimensions of the species, but they are usually less than one millimeter long. Normally they are laid in the soil in clusters of various sizes, including as many as 97 eggs. The egg has an extremely thin shell and requires a great deal of moisture for development. In my experience, the eggs will shrivel and die within a couple of hours when exposed to the normal atmosphere, even if placed on a non-absorbent surface. The larvae emerge in about six or eight days; considering the size of the egg, the newly emerged larva is quite large, usually about five millimeters long. After seven instars (usually),[2] extending over two weeks, they attain a length of nearly twenty millimeters. They feed readily on pieces of meat, fish, and injured insects; and, according to Felt, some of the larvae are predaceous, the larger ones sometimes attacking and devouring the smaller. The last instar of the larva is much longer than the others, usually lasting about a month; and if there is a second brood, this is the hibernating state. The pupa, which is formed in the soil, is much smaller than the full-grown larva; its appendages are quite free, but immovable. The adult usually emerges in a week or ten days.

The courtship and mating habits of Panorpas are especially interesting, since they introduce certain specialized traits quite inconsistent with the primitive nature of the Mecoptera. Miyaké (1912) has given

[1] Felt stated that the species was *rufescens*, but I have not seen a single specimen of this insect from that locality; in all probability the species was *canadensis*, which is common at Ithaca.

[2] Shiperovitsch (1915) claims that there are only four instars in *P. communis*.

us a splendid account of mating in *P. klugi*. The male, when approaching the female, vibrates its wings rapidly, and the female usually responds in like manner. The male then extends its abdomen and seizes that of the female with its strong forceps; these forceps are moved along the abdomen until the genitalia are reached. During copulation, which lasts from a quarter of an hour to over an hour, the bodies of the two insects diverge in the form of a "V." "One male is usually surrounded by two or three females which seem to the observer to be coquetting with the male. I saw on June 5 a pair in copulation beside two females. At last one of the two (I think the stronger one) began to disturb the pair in copulation, using its long beak as a weapon, and succeeded in separating them. The successful rival then effected a pairing on the spot" (Miyaké, 1913). Campion (1915) has made some observations on the mating habits of *P. germanica*. One pair started copulation at about 11.30 A.M. and continued all day; at night, when several aphids were introduced into the box, the pair fed together, still *in coitu*, but by 9.30 P.M. they had separated.

The most interesting aspect of the mating habits of Panorpa concerns, curiously enough, the salivary glands of the male. Brant (1839) and Dufour (1841) observed in their anatomical studies of certain neuropterous insects that the salivary glands of the male Panorpas were much larger than those of the females. Mercier (1915) studied this peculiarity more carefully in *P. germanica*, *alpina*, and *cognata*, with surprising results. He found that the salivary apparatus in the male consisted of two glands, each of which was composed of three long, filiform branches, and which opened into a common reservoir. The two reservoirs in turn opened into a common excretory duct. This development, however, was not attained until the male was four or five days old, when sexual maturity was reached. During the first few days the glandular tubes were only about two or three millimeters long; in eight days they were twelve millimeters long. He then observed that when a male, with its wings vibrating, approached a female, it suddenly ejected from its mouth a small drop of liquid, which coagulated almost the instant it was expelled, forming a small, opaline pellet, about the size of a pin-head. The male then moved several centimeters away from this pellet and again vibrated its wings. The female advanced and fed on this ball of saliva, whereupon the male approached, grasped her abdomen with his forceps, and entered into copulation. During the whole process the female continued to feed on the hard excretion, which (according to Mercier's observation) is dissolved by a brown fluid. As soon as the first pellet of saliva was

consumed, the male ejected another one, which was likewise devoured or dissolved in a similar manner. This process continued as long as the two were paired. Mercier believes that this excretion helps the male to obtain a mate.[1] Shiperovitsh (1915) has more recently repeated Mercier's observation on *P. communis*, although there seem to be some points of difference. He describes the male's ejecting several cylindrical pellets, instead of single drops of saliva. Further observation of this peculiar behavior is very desirable; I have observed the mating of several species of Panorpa but never noted such habits.

The chief characteristics which have been used in the classification of the Panorpas are the wing markings and the general aspect of the male genitalia. However, after an examination of a few hundred specimens, I became convinced that the value of the wing markings had been greatly exaggerated and the importance of the genitalia underestimated. The wing-markings appear to pass through a wide range of variations, while even the minute details of the male genitalia remain perfectly stable. It is evident that some species have been badly confused in collections, as a result of the variability of the markings; but through the kind coöperation of the several institutions concerned, I have been able to learn the details of the male genitalia of the types of all the confused species, and to place their classification on firmer ground.

The structure of the male genital bulb of Panorpa has been discussed by Miyaké (1913), Crampton (1918) and others, so that it is only necessary here to note the various parts most useful in taxonomy. The genital bulb is terminated by a pair of forceps, which vary much in shape and degree of development; in many species there is a membranous expansion or lobe on the inner surface of each of the forceps; this may be very small (*latipennis*, fig. 34), or enormously enlarged so that it covers most of the forceps (*mirabilis*, fig. 10). A ventral view (fig. 9) of the bulb shows a pair of flat appendages, the hypovalvae (hy), which extend from the hypandrium at the base of the bulb and are held close against the surface. In some species these hypovalvae are very long and slender (*virginica*, fig. 15), while in others they are short and broad (*subfurcata*, fig. 9). Extending from within the bulb on the ventral side there is another pair of appendages, the ventral valves, which exhibit a remarkable series of modifications in different species. These are strongly chitinous and very stiff; usually they are dark brown and terminate in a cluster of spines, resembling the barbs in a bird's feather.

[1] The males of Empis employ similar tactics; see also Hancock's account of the mating of Oecanthus, Amer. Nat., **39**, p. 1, 1905.

In some species the ventral valves are reduced to the merest remnants (*rufescens*, fig. 20), while in others they are elaborately developed, with branches and several clusters of the spines (*elaborata*, *braueri*, fig. 18, 26). Curiously enough, even the approximate number and direction of these spines are constant in the species. At the base of the forceps, ventrally, there are sometimes a group of large spines, and in one species (*canadensis*, fig. 19) these spines are borne on the end of a prominent projection. The inner walls of the genital bulb, when viewed ventrally, show considerable diversity in shape; in most species these walls are smoothly curved, but in others there is a prominent hump near the distal part (*virginica*, fig. 15). From a dorsal aspect of the

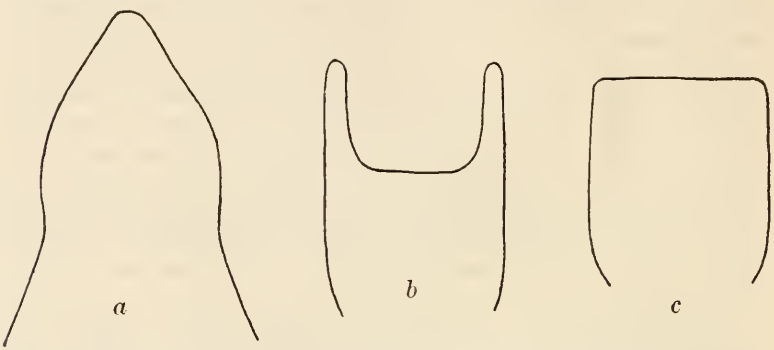

Fig. 2.— Preëpiproct of *Panorpa lugubris* Swederus (a), *P. nebulosa* Westwood (b), *P. acuta*, n. sp. (c).

bulb, only a single external appendage is visible, the preëpiproct; this is quite similar in most of our Panorpas, terminating in a pair of short lobes (*rufescens*, etc., text-fig. 2b); but in *lugubris* and its allies it terminates in a single median lobe; and in *acuta* it is without any lobes. The most remarkable feature of these genital structures mentioned above, and the one which makes them so useful in taxonomy, is their constancy in the individuals of one species, and their simultaneous modification in the different species. We do not find any noticeable modifications in any of the ventral appendages mentioned above, without finding changes in all the others as well. The utility of the male genitalia for taxonomy is greatly increased by the relatively large size of the genital bulb and the external position of the parts involved. All the genital characteristics used in the following key to the male Panorpas can be discerned with the aid of a hand lens of twenty diameters magnification.

One secondary sexual character in the male deserves mention. This is the so-called anal horn, a posterior projection of the fifth abdominal segment, which is present in most of our species of Panorpa. Previous workers on these insects have supposed that the shape of this structure was useful in the classification of the species, but I am convinced that the horn is really quite stable in form, and that the apparent variation is caused by the distortion and shriveling of the abdomen.

The females have been rather difficult to classify in the past, because they lack an obvious genital differentiation. The markings and coloration of the wings, alone, have been used. Having found the wing markings unsatisfactory in the males, I investigated the female genitalia and after much experimentation found that a certain small chitinous plate within the ninth segment possessed the desired specific variability and individual constancy. This structure was observed by Miyaké (1913, pl. 30, fig. 6, "i.s."; fig. 9) in *P. klugi*, and termed by him the *internal skeleton;* but he did not use it taxonomically. The specific identity of a female can be determined at once by the shape of this plate. Of course this structure is more difficult to examine than any of those in the male, for it is internal; but it furnishes us with a means of accurate determination, whenever the wings leave us in doubt. In no case is it necessary to remove this plate from the segment to determine its nature. If the end of the abdomen is removed from the specimen and relaxed in boiling water for a few minutes, the subgenital plate (Miyaké, 1913, pl. 30, fig. 6, "s.p.") can be bent back, exposing the internal plate. This piece of the abdomen can then be glued on a point and mounted with the insect; it can be boiled again and again without affecting the appearance of the plate in any way. Of course, if the tip of the abdomen or the chitinous plate is cleared and mounted in Canada balsam, it can easily be examined at any time. Such a small balsam mount can be made directly on a square of thick cardboard, just a little larger than an ordinary insect point; it can be placed on the same pin as the rest of the insect.

The wing markings of our Panorpas, although unstable, are nevertheless convenient for use in classification. A careful survey of the amount and nature of the variation in the several thousand Panorpas which I have examined has enabled me to determine the normal range of the variation in most species; in some the variation is very great, and in others small. The maximum degree is probably reached in *P. canadensis*, which usually has three dark bands and numerous small spots on the wings; but the specimens at high altitudes have these markings only faintly developed, and I have seen some individuals with per-

fectly spotless wings. Excepting this species, the wing-markings in our Panorpas are constant enough so that we can use them to assist in the determination of the species, provided that the doubtful cases are checked by the genitalia. In the most heavily marked species, there are three transverse bands and four spots which are useful for classification. These are: the apical band, the pterostigmal band, the basal band, the first and second basal spots, and the first and second margin spots (text-fig. 3). Curiously enough, although the degree of

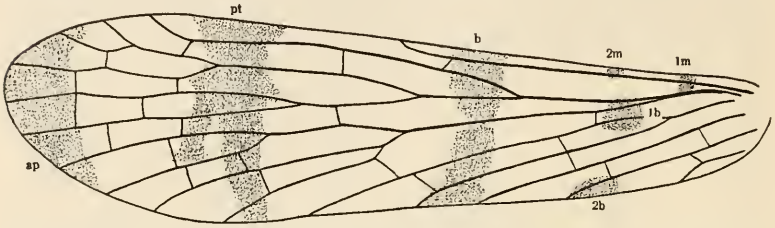

Fig. 3.— Wing markings of Panorpa: ap, apical band; pt, pterostigmal band; b, basal band; 1b, 2b, first and second basal spots; 1m, 2m, first and second marginal spots.

development of the bands may be very variable in the individuals of a species, the four spots mentioned are usually constant, to such an extent that in many species we are justified in regarding the exceptions to their presence or absence as abnormalities. The color of the wing membrane is also a convenient feature for general classification. In some species the wings are clear and colorless, in others they are distinctly yellow, and in some others they are either colorless or faintly yellow. The extreme diversity in coloration is again met in *P. canadensis;* most specimens have yellow wings, but those of high altitudes may be as colorless as the wings of *maculosa.* In most of our Panorpas, however, the wing membrane is either definitely yellow or colorless. The shape of the wings is exceedingly variable, and of no value in classification. This will become clear from the measurements of length and breadth of the wings, given for each species; a very striking example is to be found in a species named *latipennis* by Hine and *longipennis* by Banks. The color of the body of the dried Panorpa is also of little importance. Apparently the coloration under such conditions depends upon a number of external factors — the amount of grease in the body of the insects, the extent of time since the insect emerged from the pupa, etc. In one species only, *carolinensis,* the body is always black; in all the others it varies from light yellow to brown. It is

possible that specimens in alcohol may retain their natural coloration, but I have seen only a few species preserved in this way.

Miyaké has already shown that the length of the subcosta in the Japanese Panorpas is of no systematic value. The same statement applies to our species, only perhaps more emphatically. After a careful study of the venation, in which I was especially interested because of simultaneous investigations on fossil Mecoptera, I concluded that there were no venational characteristics in Panorpa that could be used for the classification of the species. The variations in the length of the subcosta, the number and arrangement of the crossveins, and even the number of branches on the radial sector are purely individualistic.

Fifteen species of Panorpa have already been described and nineteen new ones are described below, making a total of thirty-four. As suggested by Esben-Petersen (1921), these species can conveniently be

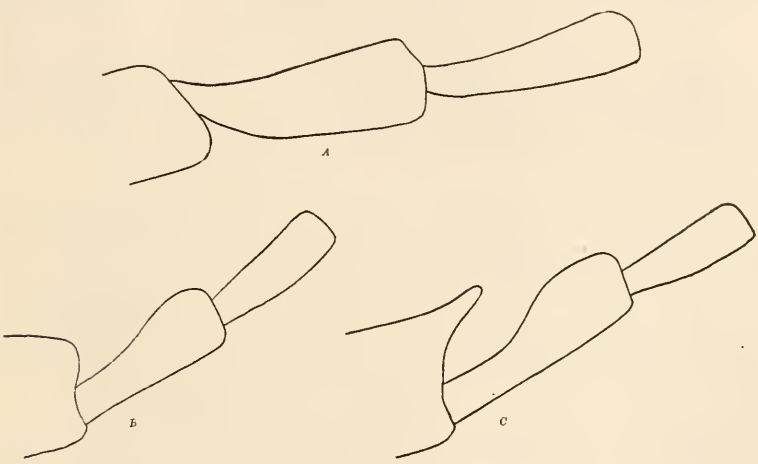

FIG. 4.— 6th, 7th, and 8th abdominal segments of Panorpa: A, *lugubris* group; B, *nebulosa* group; C, *rufescens* group.

divided into three sections which we shall call the *lugubris*, *nebulosa*, and *rufescens* groups, and which may deserve the rank of subgenera, although they are not so designated here. The following key to the males shows distinctly the species included in each group. In the key to the females I have used the wing-markings as much as possible, but in some cases I have been unable to find any satisfactory differences except in the genital structure.

Key to the Males of Panorpa

1. Seventh and eighth abdominal segments elongate and slender; hypovalvae short, uniting near the middle of the genital bulb; preëpiproct with a single median lobe (text-fig. 2a).
(*lugubris* group) 2

Seventh and eighth abdominal segments relatively short, hypovalvae more prominent, arising at almost the base of the genital bulb; preëpiproct with a pair of lobes or truncate, without lobes (text-fig 2b, c) 4

2. Wings black or very dark brown, with a few small, white spots near the middle (fig. 76) ..... *lugubris*

Wings yellow, with black or brown bands 3

3. Pterostigmal band forked posteriorly (fig. 78) ..... *rufa*

Pterostigmal band not forked (fig. 77) ..... *nuptialis*

4. Anal horn absent (*nebulosa* group) 5

Anal horn present (*rufescens* group) 12

5 Interior of genital bulb extending upward between the forceps .. 6

Interior of bulb concealed 7

6. Genital forceps slender, smoothly curved (fig. 40) ..... *maculosa*

Genital forceps broad, abruptly curved apically (fig 41).
submaculosa, n. sp.

7. Ventral valves sigmoidally curved (fig. 37) ..... *sigmoides*, n. sp.

Ventral valves straight or nearly so 8

8. Genital bulb elongate; forceps small, only about one-half the length of the rest of the bulb (fig. 36) ..... *chelata*, n. sp.

Genital bulb shorter; forceps distinctly over one-half the length of the rest of the bulb 9

9. Preëpiproct truncate, without lobes (fig. 38, text-fig. 2c).
acuta, n. sp.

Preëpiproct with a pair of lobes (text-fig. 2b) 10

10. Forceps with a small, slender lobe near the inner margin (fig. 34).
latipennis

Forceps without lobes 11

11. Genital bulb and hypovalvae slender; ventral valves straight; wing membrane faintly yellow (fig. 30) ..... *banksi*

Genital bulb and hypovalvae broad, ventral valves curved; wing membrane colorless (fig. 35) ..... *nebulosa*

12. Forceps with large lobes 13

Forceps with small lobes or entirely without them 18

13. Hypovalvae broad, with an abrupt bend at the middle 14

Hypovalvae straight and usually slender 15

14. Forceps much longer than the rest of the bulb; lobes of forceps enormous, covering all but the very tips of the forceps (fig. 10). *mirabilis*, n. sp
Forceps shorter than the rest of the bulb; lobes of forceps smaller (fig. 9) ..... *subfurcata*
15. Wing membrane yellow (fig. 15) ..... *virginiea*
Wing membrane colorless 16
16. Ventral valves reaching to end of forceps; lobes of forceps elongate, with parallel sides (fig. 12) ..... *longicornis*, n. sp.
Ventral valves not reaching beyond middle of forceps; lobes of forceps with irregular margins 17
17. Outer margins of forceps smoothly curved; ventral valves thickened basally (fig. 14) ..... *modesta*, n. sp.
Outer margins of forceps abruptly curved apically; ventral valves very slender throughout (fig. 11) ..... *signifer*
18. Two or more long and thick spines at base of forceps 19
No such spines at base of forceps 20
19. Wings very broad; first margin and basal spots fused, forming a short, transverse band (fig. 17) ..... *amerieana*
Wings slender; first marginal and basal spots independent (fig. 16). *venosa*
20. Ventral valves without barbs, and bent toward each other, the apices crossing 21
Ventral valves with barbs, and without prominent curves 23
21. Body black (fig. 13) ..... *carolinensis*
Body yellow or brown 22
22. Forceps with deeply incised inner margins; inner walls of genital bulb smoothly curved (fig. 33) ..... *gracilis*, n. sp.
Forceps with prominent projecting teeth on inner margins; inner walls of bulb with pronounced hump (fig. 27) ..... *interrupta*
23. Ventral valves simple, usually straight, without tufts of barbs, and without branches 24
Ventral valves with tufts of barbs or branches 27
24. Hypovalvae and ventral valves about the same length 25
Hypovalvae much shorter than ventral valves 26
25. Genital bulb elongate (fig. 23) ..... *neglecta*, n. sp.
Genital bulb rounded (fig. 21) ..... *robusta*, n. sp.
26. A single oblique, conical (usually) papilla at base of forceps, surmounted by hairs; outer edge of forceps only slightly curved apically (fig. 19) ..... *canadensis*

No papilla at base of forceps; outer edge of forceps strongly curved (fig. 39) ..... *claripennis*

27. Ventral valves long, extending far between forceps 28
Ventral valves short, reaching at most only slightly beyond bases of forceps 29

28. Ventral valves with a tuft of barbs near the base (fig. 31). *dissimilis*, n. sp.
Ventral valves with several tufts of barbs apically, none basally (fig. 28) ..... *decorata*, n. sp.

29. Ventral valves small, concealed within the interior of the bulb, and joined together at the base, forming a "U" (fig. 20). *rufescens*
Ventral valves larger, not united at base 31

30. Ventral valves with branches 30
Ventral valves without branches 34

31. Genital bulb rounded; forceps as long as the rest of the bulb; hypovalvae broad (fig. 25) ..... *speciosa*, n. sp.
Genital bulb oval; forceps much shorter than the rest of the bulb; hypovalvae slender 32

32. Hypovalvae very short, not nearly reaching to the base of the forceps 33
Hypovalvae longer, reaching to the bases of the forceps or nearly so (fig. 18) ..... *elaborata* n. sp.

33. Ventral valves consisting of two long, slender branches, which diverge at the base (fig. 29) ..... *anomala*, n. sp.
Ventral valves consisting of two short, thick branches, which separate distally (fig. 32) ..... *proximata*, n. sp.

34. Ventral valves small, not reaching beyond the base of the forceps (fig. 26) ..... *braueri*, n. sp.
Ventral valves longer, extending beyond the bases of the forceps 35

35. Hypovalvae very short, about one-half as long as the bulb (not including forceps); bulb rounded (fig. 24) ..... *dubitans*, n. sp.
Hypovalvae longer, about two-thirds as long as the bulb; bulb elongate (fig. 22) ..... *isolata*, n. sp.

Key to the Females of Panorpa

The females of the following species are unknown: *banksi* Hine, *acuta*, n. sp., *modesta*, n. sp., *gracilis*, n. sp., *neglecta*, n. sp., *robusta*, n. sp., *dissimilis*, n. sp., *decorata*, n. sp., *speciosa*, n. sp., *proximata*, n. sp., *dubitans*, n. sp.

1. Wings black or very dark brown, with a few scattered white spots ..... *lugubris*
   Wings yellow or colorless, with bands or spots (fig. 76) 2
2. Marginal spots fused, forming a short band along the basal part of the anterior border 3
   Marginal spots independent or absent 4
3. Pterostigmal band forked posteriorly (fig. 78) ..... *rufa*
   Pterostigmal band not forked (fig. 77) ..... *nuptialis*
4. No marginal spots present 5
   At least one marginal spot present 16
5. Crossveins not margined 6
   Crossveins margined 10
6. Second basal spot absent 7
   Second basal spot present 9
7. Wing membrane yellowish (fig. 51) ..... *venosa*
   Wings membrane colorless 8
8. Internal skeleton as in fig. 55 ..... *subfurcata*
   Internal skeleton as in fig. 48 ..... *mirabilis*, n. sp.
9. Internal skeleton as in fig. 54 ..... *signifer*
   Internal skeleton as in fig. 50 ..... *carolinensis*
   Internal skeleton as in fig. 49 ..... *longicornis*, n. sp.
10. At least one continuous band on fore wing 11
    All bands on fore wing broken or reduced to a series of spots 13
11. Wing membrane yellowish (fig. 61) ..... *canadensis*
    Wing membrane colorless 12
12. Fore wing usually broadened distally (fig. 85) ..... *claripennis*
    Fore wing usually slender ..... *latipennis*
13. Large insects, fore wing at least 13 mm. long (fig. 64) ..... *latipennis*
    Small species, fore wing under 10 mm. long 14
14. Fore wing broad (fig. 61) ..... *canadensis*
    Fore wing narrow 15
15. Internal skeleton as in fig. 46 ..... *maculosa*
    Internal skeleton as in fig. 65 ..... *nebulosa*
    Internal skeleton as in fig. 66 ..... *sigmoides*, n. sp.
    Internal skeleton as in fig. 60 ..... *submaculosa*, n. sp.
    Internal skeleton as in fig. 63 ..... *chelata*, n. sp.
16. One marginal spot present 17
    Both marginal spots present 21
17. Crossveins margined 18
    Crossveins not margined 19

18. Internal skeleton as in fig. 58 ..... *rufescens*
    Internal skeleton as in fig. 53 ..... *interrupta*
19. Wing membrane colorless (fig. 54) ..... *signifer*
    Wing membrane yellow 20
20. Wing membrane pale yellow (fig. 51) ..... *venosa*
    Wing membrane deep yellow (fig. 52) ..... *virginica*
21. Fore wing broad (fig. 79) ..... *americana*
    Fore wing narrow 22
22. Internal skeleton as in fig. 59 ..... *anomala*
    Internal skeleton as in fig. 45 ..... *isolata*
    Internal skeleton as in fig. 62 ..... *braueri*
    Internal skeleton as in fig. 56 ..... *elaborata*

Panorpa lugubris Swederus

Figs. 6, 44, 76

Panorpa lugubris Swederus, 1787, Kgl. Svenska Vetensk.-Akad. Nya Handl., **8**, p. 279. Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 188. Hagen, 1861, Syn. Neurop. N. A., p. 241. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 241, pl. 59, fig. 7. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 59, pl. 2, fig. 15.

Panorpa scorpio Fabricius, 1793, Ent. Syst., **2**, p. 97.

Body very dark brown or black. Fore wing: length, 10–12 mm.; width, 3 mm.; membrane black or very dark brown, with a few scattered white spots. ♂ genitalia: forceps longer than rest of genital bulb and strongly curved; tooth at base of forceps rounded. ♀ genitalia: internal skeleton broad, axis very broad; plate widest posteriorly, sides quite straight.

Types (♂ ♀).— "America Septentrionale"; in British Museum.

Distribution.— North Carolina, South Carolina, Georgia, Alabama, and Florida; September to December.

The dark wings of this species readily distinguish it from all other Panorpas. It is essentially a coastal species, although several specimens have been taken as far inland as Atlanta, Georgia.

Panorpa rufa Gray

Figs. 7, 43, 78

Panorpa rufa Gray, 1833, *in* Griffith's ed. Cuvier's Animal Kingdom, Insects, **15**, p. 323, pl. 105, fig. 2. Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 188. Hagen, 1861, Syn. Neurop. N. A., p. 242. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 246. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 58, fig. 65; pl. 2, fig. 14.

Panorpa fasciata (in part) Klug (*nec* Fabricius), 1836, Abh. Königl. Akad. Wiss. Berlin, 1836, p. 105. Rambur, 1842, Hist. Nat. Ins., Neurop., p. 331, pl. 8, fig. 5.

Body brown to reddish brown. Fore wing: length 13 mm.; width, 4 mm.; wing membrane light yellow, bands broad, brown; apical band and basal band continuous; pterostigmal band always forked posteriorly; second basal spot large; anterior margin of wing, basad of basal band, bordered with brown; crossveins not margined. ♂ genitalia: genital bulb slender; forceps less than half the length of the rest of the bulb; tooth at base of forceps large and rounded; preëpiproct broad distally. ♀ genitalia: internal skeleton broad and large; axis very broad; plate widest near the middle, sides slightly convex.

Types (♂ ♀).— Georgia; in British Museum.

Distribution.— North Carolina (Southern Pines, October 10–20, A. H. Manee; Southern Pines, October 19, May 10, C. S. Brimley; Wilmington, December 25); "Georgia" (type).

This is a very local and rare species. For over seventy years the types were the only specimens known, but in 1909 Manee secured a large series at Southern Pines, and other collectors have taken a few more specimens in the same vicinity. In the Museum of Comparative Zoölogy there is a male labeled "Georgia," without more definite data. The species probably occurs along the South Carolina coast.

Panorpa nuptialis Gerstaecker

Figs. 8, 42, 77

Panorpa nuptialis Gerstaecker, 1863, Stett. Ent. Zeit., p. 112. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 246, pl. 49, fig. 2; pl. 51, figs. 26, 33. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 60.

Body brown to reddish brown. Fore wing: length, 17 mm.; width, 5 mm.; membrane yellow, with wide black or brown bands, all continuous; posterior margin of wing, basad of basal band, bordered with black or brown; first marginal and second basal spots enlarged and fused; crossveins not margined. ♂ genitalia: forceps longer than rest of genital bulb, abruptly bent at middle; tooth at base of forceps pointed; preëpiproct narrow distally. ♀ genitalia: internal skeleton slender; axis narrow, forked anteriorly of plate; sides of plate concave.

Holotype (♀).— Texas (Freidrich); in Greifswald University.

Allotype, by present designation.— Dallas, Texas, October 15; in Museum of Comparative Zoölogy.

Distribution.— Eastern Kansas, Missouri, Arkansas, Louisiana,

eastern Texas; September to January. I have also seen a male of this species collected at Baxter Springs, Kansas, July 17 (W. R. Ballard); this is the only record earlier than September that I have noted. Hine records *nuptialis* from Mississippi, and Esben-Petersen mentions it in "Mexico," but I have seen no specimens from these localities.

This is the largest and most striking of all the North American Panorpas. It is commonest in eastern Texas, and relatively rare in the northern limits of its range.

Panorpa subfurcata Westwood

Figs. 9, 55, 80

Panorpa subfurcata Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 191. Hagen, 1861, Syn. Neurop., N. A., p. 244. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 249. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 66, fig. 70.

Body brown; anal horn present. Fore wing: length, 12–14 mm.; width, 3–4 mm.; membrane colorless, bands brown or dark gray; apical band usually entire, rarely with a few clear spots; pterostigmal band either continuous or interrupted; first basal spot present, sometimes connected with the top of the basal band; second basal and both marginal spots absent; crossveins not margined. ♂ genitalia: forceps with a large lobe; hypovalvae not reaching to the base of the forceps, broad, and bent near the middle; ventral valves long, extending well up between the forceps. ♀ genitalia: axis of internal skeleton extending beyond plate about as much as within plate; plate triangular, widened posteriorly; posterior margin of plate with a broad, shallow incision.

Types (♂ ♀).— "Nova Scotia"; in British Museum.

Distribution.— Quebec, New England, New Jersey, New York, Pennsylvania; late May to middle of August. In the Museum of Comparative Zoölogy there is a male labeled "Wisconsin," without date or exact locality; since I have seen no other specimens from regions west of Ithaca, N. Y., I am inclined to consider this an error.

This species resembles *signifer* Banks and has frequently been confused with it in collections; Hine's descriptions show that he had not succeeded in distinguishing the females. The second basal spot is always absent in *subfurcata* but present in *signifer*. Both Hine and Esben-Petersen state that the pterostigmal band is forked posteriorly, but this is not always the case.

Panorpa mirabilis, n. sp.

Figs. 10, 48

Body brown to yellow; anal horn present. Fore wing: length, 12 mm.; width, 3 mm.; membrane colorless, bands and spots gray-brown, sometimes black; apical band entire, rarely with a few weak clear spots; pterostigmal band continuous; basal band broken at middle; first basal spot well developed, usually prolonged and connected with the basal band; second basal and both marginal spots absent; crossveins not margined. ♂ genitalia: genital bulb elongate; forceps with an enormous lobe, concealing the forceps themselves except for the very tips, each lobe with a prominent basal tooth; hypovalvae broad and bent at the middle, not reaching the base of the forceps; ventral valves long and slender, extending well up between the forceps; inner margins of bulb with prominent humps. ♀ genitalia: internal skeleton long; axis beyond plate twice as long as within plate; plate widest posteriorly, sides very slightly convex; posterior margin with deep, broad incision.

Holotype (♂).— Andover, New Jersey, May 24, 1923 (F. M. Schott); in the United States National Museum.

Allotype.— Douglas Lake, Cheboygan Co., Michigan, July 1, 1925 (C. F. Byers); in Museum of Zoölogy, University of Michigan.

Paratypes.— 1 ♂, Long Island, New York, June 17, 1901; 1 ♀, Stroudsburg, Pennsylvania, June 6, 1918 (J. M. Knull); 1 ♀, Douglas Lake, Michigan, July 1, 1925 (C. F. Byers); in Museum of Comparative Zoölogy. 1 ♂, Ann Arbor, Michigan, May 22, 1918 (F. M. Gaige); 1 ♂, Ann Arbor, Michigan, June 13, 1917; 1 ♀, Cecil Bay, Emmet Co., Michigan, July 6, 1925 (C. F. Byers); 3 ♀, Ann Arbor, Michigan, June 28, 1920 (T. H. Hubbell); 2 ♀, Ann Arbor, Michigan, June 10, 1917 (T. H. Hubbell); 1 ♀, Ann Arbor, Michigan, May 25, 1921 (T. H. Hubbell); 1 ♀, Ann Arbor, Michigan, July 25, 1927; 1 ♀, Washtenau Co., June 3, 1930; all in the Museum of Zoölogy, University of Michigan. 1 ♂, Douglas Lake, Michigan, July 14, 1927 (L. K. Gloyd); 1 ♂, Ann Arbor, Michigan, June 10, 1921 (T. H. Hubbell); 1 ♀ Washtenau Co., June 3, 1930; all in the writer's collection.

This species has the most remarkable genital structure of all the North American Panorpas. The lobes on the forceps reach a development far in excess of that in *subfurcata*. The wings are closest to those of the latter, and I cannot find any satisfactory differences in the markings, so that the genitalia must be examined for the separation of the females of these two species.

Panorpa signifer Banks

Figs. 11, 54, 81

Panorpa signifer Banks, 1900, Trans. Ent. Soc. Amer. **26**, p. 251. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 249, pl. 59, fig. 8; pl. 60, fig. 12. Esben-Petersen, 1911, Coll. Zoöl. Selys Longchamps, **5** (2), p. 68, fig. 73.

Body brown to yellow; anal horn present. Fore wing: length, 11–14 mm.; width, 2.5–4 mm.; membrane colorless, bands gray or brown; apical band usually broken; pterostigmal band always continuous and nearly always forked posteriorly; basal band usually continuous, occasionally broken; first and second basal spots always present, sometimes fused; both marginal spots normally absent, but the first is sometimes weakly developed; crossveins not margined. ♂ genitalia: forceps with a small lobe; hypovalvae slender and straight, reaching to the base of the forceps; ventral valves extremely slender, extending far between the forceps; inner walls of bulb with small, rounded humps. ♀ genitalia: internal skeleton slender, axis projecting beyond plate for almost one-half the length of the plate; sides of plate concave, posterior margin deeply cleft, with a small tooth in the middle.

Holotype (♂).— Gaylord, Michigan, July 19, 1894 (R. H. Pettit); in Museum of Comparative Zoölogy.

Allotype, by present designation.— Pittsfield, Mass., August 10, 1930 (F. M. Carpenter); in Museum Comparative Zoölogy.

Distribution.— Cape Breton Island, Nova Scotia, southern Ontario, New England, New York, eastern Pennsylvania, Michigan, Wisconsin, Minnesota; late May to early September.

This is a northern species, not yet found below the 41° latitude; the most southern record known to me is North Mt., Pennsylvania, at an altitude of 2,000 ft. The specimens recorded by Sherman in his list of the Mecoptera of North Carolina (1908) and placed in this species are really *carolinensis*, distinguished by many differences in genital structure. The ♂ genitalia are closest to those of *virginica*, but they have broader ventral valves and larger humps on the inner walls of the bulb. The wing markings are more like those of *longicornis*, a new species which has not been taken outside of Tennessee and western North Carolina.

Panorpa carolinensis Banks

Figs. 13, 50

Panorpa carolinensis Banks, 1905, Bull. Amer. Mus. Nat. Hist., **21**, p. 216. Banks, 1906, Trans. Ent. Soc. Amer., **32**, p. 8. Esben-Petersen, Coll. Zoöl. Selys Longchamps, **5** (2), p. 69.

Body black; anal horn present. Fore wing: length, 13 mm.; width, 4 mm.; membrane colorless, sometimes grayish; bands dark brown or more often black; apical band broad, entire or interrupted; pterostigmal band continuous, and usually forked posteriorly; basal band broad, narrow at middle; both basal spots present, but both marginal spots absent; crossveins not margined. ♂ genitalia: forceps slender, with unusually curved tips and with narrow, truncate lobes; hypovalvae slender, reaching to the base of the forceps; ventral valves broad, curved inwards, without barbs; inner walls of bulb with distinct humps. ♀ genitalia: internal skeleton small, the axis reduced to a small vestige in the center of the plate; plate broader anteriorly than posteriorly; posterior margin with a deep incision.

Cotypes.— 1 ♂, Black Mts., North Carolina, June (Wm. Beutenmüller); 1 ♀, Black Mts., June (Wm. Beutenmüller); both in Museum of Comparative Zoölogy. 3 ♀, Black Mts., June (Wm. Beutenmüller); in American Museum of Natural History.

Distribution.— North Carolina: Craggy Mts., July 1, June 8; Sunburst, May (C. S. Brimley); Andrews, July 24 (F. Sherman); Mt. Mitchell, 6,000 ft., June and July. Tennessee: Smoky Mts., near Newfound Gap, 5,000 ft., August 30, 31, 1930 (F. Carpenter, N. Banks, P. J. Darlington, Jr.).

This species appear to be restricted to the Black Mts., Smoky Mts., and associated ranges, and occurs at rather high altitudes. It also seems to be a local species, and is by no means common. Banks states in his description that the body is brown; but all the types, as well as the additional specimens which I have seen, have black bodies, although the head is sometimes reddish.

Panorpa longicornis, n. sp.

Figs. 12, 49

Body brown to reddish brown; anal horn present. Fore wing: length, 13 mm.; width, 3.5 mm.; membrane colorless; bands and spots brown, usually light; apical band entire; pterostigmal band continuous; basal band either continuous or interrupted; both basal spots, both marginal

spots absent; crossveins not margined. ♂ genitalia: forceps with a small lobe, much like that of *carolinensis*, but a little longer; hypovalvae slender, extending beyond base of forceps; ventral valves extraordinarily slender and elongate, extending to the very tips of the forceps; inner walls of bulb with large humps. ♀ genitalia: internal skeleton small, short; axis entirely within plate, the two forks diverging strongly, anteriorly; plate broadest anteriorly; posterior margin of plate deeply and broadly incised.

Holotype (♂).— Smoky Mts., Tennessee, near Newfound Gap, 3,500 ft., September 1, 1930 (F. Carpenter); in Museum of Comparative Zoölogy.

Allotype.— Same locality, August 30, 1930 (F. Carpenter).

Paratypes.— 5 ♂, 10 ♀, Smoky Mts., near Newfound Gap, 3,500 ft., Tennessee, August 30, 31, 1930 (F. Carpenter, P. J. Darlington, Jr.); 1 ♂, Mt. Graybeard, North Carolina, May 23; 2 ♀, Blowing Rock, North Carolina, August 13 (G. P. Engelhardt); 1 ♂, Blowing Rock, North Carolina, September (F. Sherman); all in Museum of Comparative Zoölogy. 2 ♀, Blowing Rock, North Carolina, September, 1915 (F. Sherman); 1 ♀, Blowing Rock, North Carolina, August, 1905 (F. Sherman); 1 ♀, Blowing Rock, North Carolina, August, 1906 (F. Sherman); 2 ♀, Blowing Rock, North Carolina, September 4, 1915 (R. W. Leiby); 1 ♀, Blowing Rock, North Carolina, September 12, 1912 (C. S. Brimley); 1 ♀, Grandfather Mt., North Carolina, 5,000 ft., September 11, 1908 (Z. P. Metcalf); 2 ♀, Grandfather Mt., North Carolina, 4–5,000 ft., early September (F. Sherman); all in North Carolina department of agriculture collection, Raleigh. 1 ♂, 2 ♀, Blowing Rock, North Carolina, August 13; in Brooklyn Museum, New York. 1 ♂, Mt. Graybeard, North Carolina, May 23; in J. E. Davis collection. 3 ♂, 6 ♀, Smoky Mts., near Newfound Gap, Tennessee, 3,500 ft., August 30, 31, 1930 (F. Carpenter); 1 ♀, Blowing Rock, Linville, North Carolina, September 9 (F. Sherman); 1 ♀, Grandfather Mt., North Carolina, 4,000 ft., September, 1907 (F. Sherman); 1 ♀, Blowing Rock, North Carolina, September, 1915 (F. Sherman); 1 ♂, Black Mts., Little Switzerland, North Carolina, August 31, 1930 (W. S. Creighton); all in writer's collection. 1 ♂, 3 ♀, Carter Co., Roan Mt., Tennessee, 6,000 ft., August 6, 1922 (T. H. Hubbell); in Museum of Zoölogy, University of Michigan.

This species resembles *carolinensis* in its range and general appearance.; but it is apparently restricted to lower altitudes than *carolinensis*, and can readily be distinguished by the brown body, as well as the striking genital features. No specimens of *longicornis* seem to have

been taken during June or July, so it probably has a spring and fall brood.

Panorpa modesta, n. sp.

Fig. 14

Body brown; anal horn present. Fore wing: length, 13 mm.; width, 3 mm.; membrane colorless; markings dark brown; apical band interrupted, pterostigmal and basal bands continuous (in type); first and second basal spots present; both marginal spots absent; crossveins not margined. ♂ genitalia: forceps slender, as long as rest of bulb, with long, smoothly curved tips; forceps with a large lobe near the base, similar to that in *interrupta*, but more inclined; hypovalvae slender, reaching to base of forceps; ventral valves long and slender; inner walls of bulb deeply incised posteriorly. Female unknown.

Holotype (♂).— Douglas Lake, Michigan, August, 1927 (L. K. Gloyd); in Museum of Comparative Zoölogy.

I have seen only one specimen of this species. The wings resemble those of *signifer*, but the genital structure is very unusual; the slenderness of the forceps and the shape of the lobe on the forceps enable easy recognition. The incision on the inner walls of the bulb is a character which I have not seen in any other Panorpa.

Panorpa virginica Banks

Figs. 15, 52

Panorpa virginica Banks, 1906, Psyche, **13**, p. 99, fig. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 70, fig. 74.

Body yellow to brown; anal horn present. Fore wing: length, 11–12 mm.; width, 3 mm.; membrane yellow, with dark brown or black markings; apical band usually interrupted; pterostigmal band continuous; basal band usually broken at middle; first basal spot strongly formed, second basal spot reduced to a faint darkening at the termination of 2A; first marginal spot always present, second one absent; crossveins not margined. ♂ genitalia: apices of forceps strongly curved; forceps with a large lobe; hypovalvae slender, extending a little beyond the base of the forceps; ventral valves long and slender; inner walls of bulb with a large projecting lobe. ♀ genitalia: internal skeleton long and slender; axis projecting beyond the plate; sides of plate slightly convex; posterior margin deeply cleft.

Type (♂).— Glencarlyn (near Falls Church), Virginia, October 10 (N. Banks); in Museum of Comparative Zoölogy.

Allotype.— Falls Church, Virginia, September 6 (N. Banks); in Museum of Comparative Zoölogy.

Distribution.— North Carolina, Virginia, South Carolina (Pickens Co., 4,300 ft., September 20, October 14, F. Sherman), Tennessee (near French Broad River, 6 mi. west of North Carolina line, 1,200 ft., August 30, 1930, F. Carpenter), Georgia (Stone Mt., June 2, 1930, P. W. Fattig), Arkansas (Bentonville, September 4, 1928, H. H. Schwardt), New Jersey (Lake Hopatcong, July 6), Connecticut (Stafford, August 24), Michigan (Douglas Lake, August 8, 1927, L. K. Gloyd); August to early October. The specimen mentioned from Georgia is the only record earlier than August that I have seen. The wings of this species resemble those of *venosa*, but the genitalia are more like those of *signifer*. The wing membrane is a more brilliant yellow than in *venosa*. *Virginica* seems to be commonest in North Carolina, especially in the mountainous regions; but specimens have turned up in remote localities, as mentioned above.

Panorpa venosa Westwood

Figs. 16, 51

Panorpa venosa Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 190. Hagen, 1861, Syn. Neurop. N. A., p. 242. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 250, pl. 49, fig. 4; pl. 50, figs. 18, 23; pl. 51, fig. 38. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 66, fig. 71.

Panorpa fasciata Klug, (in part), 1826, Abh. Köngl. Akad. Wiss. Berlin, p. 105.

Body brown to yellow; anal horn present. Fore wing: length, 11–12 mm.; width, 3 mm.; membrane yellowish usually, sometimes nearly colorless; apical band usually entire, but occasionally interrupted; pterostigmal band and basal band usually continuous; first basal spot present, second one reduced to a slight darkening at the termination of 2A; first marginal spot absent in most specimens, sometimes feebly developed; second marginal spot always absent; crossveins not margined. ♂ genitalia: forceps with a long base and a short curved tip; hypovalvae slender, straight, extending well beyond base of forceps; two heavy spines at the inner side of the base of each of the forceps; ventral valves reaching a little beyond hypovalvae. ♀ genitalia: internal skeleton large, axis projecting only a short distance beyond plate; sides of plate convex; posterior margin with a "V"-shaped incision.

Holotype (♀).— "Georgia"; in British Museum.

Allotype.— Paeonian Springs, Virginia, June 28 (N. Banks); in Museum of Comparative Zoölogy.

Distribution.— Massachusetts (Lowell, June 17, 1879), southern New York, Connecticut, New Jersey, Pennsylvania, Maryland, Virginia (Fairfax Co.), North Carolina, South Carolina (Liberty, September 29), West Virginia (Aurora, August), Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Manitoba (Winnipeg, July 6, J. B. Wallis); late May to October. Esben-Petersen records the species from Iowa.

This is the most widely distributed of all the American Panorpas, although it does not extend very far into New England. In general appearance it resembles *virginica*, although the wing membrane is a paler yellow than in the latter. Specimens of *venosa* from the coastal states have a more yellow membrane than those farther inland; and specimens from Michigan, Wisconsin, Minnesota, Indiana, and Ohio, have a nearly colorless membrane.

Westwood's type was a female, and it has not been possible for me to determine the nature of the internal skeleton in this specimen. Hagen, however, examined Westwood's type and identified several specimens in his collection by comparison. These latter insects I have been able to study at the Museum of Comparative Zoölogy; they belong to one species, with the genital structure described and figured above. I believe it is almost certain that we are dealing here with the real *venosa*.

Panorpa americana Swederus

Figs. 17, 57, 79

Panorpa americana Swederus, 1787, Köngl. Svenska Vetensk.-Akad., Nya Handl., **8**, p. 279. Westwood, 1841, Trans. Ent. Soc. Lond., **4**, p. 189. Hagen, 1861, Syn. Neurop. N. A., p. 242. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 250, pl. 59, fig. 5. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2) p. 65.

Panorpa fasciata (in part) Fabricius (*nec* Klug), 1793, Ent. Syst., **2**, p. 98.

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 4.5 mm.; markings dark brown; apical, pterostigmal, and basal bands always continuous; first basal spot well developed and fused with the first marginal spot; second basal and second marginal spots absent; crossveins not margined. ♂ genitalia: forceps small, sharply pointed; hypovalvae slender, reaching to the bases of the forceps; ventral valves short, widened distally; two large, heavy spines at the inner

base of the forceps, much more conspicuous than those in *venosa;* inner walls of bulb almost straight. ♀ genitalia: internal skeleton large, the axis projecting only a little beyond the plate; plate broadest at the middle, much narrowed anteriorly; posterior margin with a deep and narrow incision.

Types (♂ ♀).— "Georgia" (Dury); in British Museum.

Distribution.— Northern Florida, southern Alabama (Auburn, Mobile, Kushla), Louisiana (Shreveport), North Carolina (Raleigh, Southern Pines, Statesville, Liberty), New Jersey (Hammonton, September 6, 1903); September and October. Hagen records this insect from Kentucky.

This rare species resembles *nuptialis* superficially, but it is much smaller and has broader bands on the wings. The two large spines at the bases of the forceps are very prominent and are sufficient to separate this species from all others.

Panorpa rufescens Rambur

Figs. 20, 58, 83

Panorpa rufescens Rambur, 1842, Hist. Nat. Inst., p. 330. Hagen, 1861, Syn. Neurop. N. A., p. 241. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 251, pl. 59, fig. 10; pl. 60, figs. 11, 12; pl. 61, fig. 31. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 63, fig. 68; pl. 1, fig. 6.

Panorpa debilis Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 191. Hagen, 1861, Syn. Neurop. N. A., p. 243.

Panorpa confusa Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 190. Hagen, 1861, Syn. Neurop. N. A., p. 244. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 251, pl. 60, fig. 13; pl. 61, figs. 27, 34. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 64, fig. 69.

Body brown to yellow; anal horn present. Fore wing: length, 10–12 mm.; width, 3 mm.; membrane yellowish, markings dark brown or black; apical band usually interrupted, sometimes only the vestige remaining; pterostigmal band nearly always continuous; basal band broken at middle; first basal spot well developed, second one absent; first marginal spot present, second one absent; crossveins margined. ♂ genitalia: forceps short, abruptly curved distally; hypovalvae slender, reaching to base of forceps; ventral valves very small, fused basally, forming a wide "U"; inner walls of bulb with a definite lobe. ♀ genitalia: internal skeleton short, but complicated; axis projecting only a short distance beyond the plate, the forks divergent; sides of plate convex anteriorly, concave posteriorly; posterior margin with a very narrow and deep incision.

Types (♂ ♀).— "Amerique septentrionale"; in Royal Museum of Natural History, Brussels, Belgium.

Distribution.— Southern New Hampshire, eastern Massachusetts, Connecticut, Rhode Island, New York (mostly southern), New Jersey, eastern Pennsylvania, Maryland, eastern Virginia (Fairfax Co.), North Carolina, Georgia (Stone Mt., June 6, 1930, P. W. Fattig); Florida (Greenville, Madison Co., April 23, 1924, T. H. Hubbell), Michigan (Detroit); late May to September, in the more northern states; in North Carolina and southward, as early as April and as late as the middle of October.

Rufescens introduces a series of species usually called collectively the "*confusa* group," although the members have no relationship except that they have been much confused in collections. Rambur described *rufescens* in 1842, and Westwood described *confusa* and *debilis* in 1846 without knowing of Rambur's description of *rufescens;* at least he makes no reference to Rambur's insect in his "Monograph of the genus Panorpa" (1846). He separated *debilis* from *confusa* by the paler wing markings. Hine concluded from his comparison of the descriptions that *debilis* was synonymous with *rufescens*, and Esben-Petersen followed this classification. In order to settle the question more satisfactorily, I sent specimens of all the species of Panorpa in the "*confusa* group," together with drawings and notes, to Dr. H. Eltringham of the British Museum, and to Dr. A. Ball of the Royal Natural History Museum at Brussels; since the types of *confusa* and *debilis* were at the former, and the types of *rufescens* at the latter. From the comparisons made by these two authorities, it became clear that *debilis* is identical with *confusa*, and *confusa* the same as *rufescens*. *Canadensis* Banks resembles *rufescens* closely, but it has a very different genital structure. One new species, *elaborata*, has also been confused with *rufescens* and was figured by Esben-Petersen as *confusa* (fig. 69); but it has distinctive wing markings and genital features. Both sexes of *rufescens*, *canadensis*, and *elaborata* can be recognized, not only by the genital structure, but by the wing markings: in *canadensis* there are no marginal spots; in *rufescens*, there is only the first marginal; and in *elaborata*, there are both marginals. Exceptions to this statement do not exceed a total of 1%.

As will be seen from the above localities, *rufescens* is essentially a coastal species, avoiding the highlands. I have collected Panorpas extensively for several years in the Berkshire hills of Massachusetts, but have never taken a specimen of *rufescens* there. It has not been taken in the White Mts., New Hampshire, nor in the region of Ithaca, where

many Panorpas have been collected by the students at Cornell University. The only record for northern New York is close to the shores of Lake Ontario (Brownville, July 7), and the Michigan locality is on the edge of Lake Erie.

Panorpa canadensis Banks

Figs. 19, 61, 84

Panorpa canadensis Banks, 1895, Trans. Ent. Soc. Amer., **22**, p. 315. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 252, pl. 60, fig. 24; pl. 61, fig. 39. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 67, fig. 72.

Body brown to yellow; anal horn present. Fore wing: length, 10–11 mm.; width, 3 mm.; membrane yellow, markings dark brown or black; apical band usually entire, sometimes broken and even almost absent; pterostigmal band continuous or interrupted, rarely entirely absent; basal band never continuous; first basal spot well developed usually; second basal and both marginal spots absent; crossveins margined, except in those specimens without bands or spots. ♂ genitalia: forceps slender, without lobes; hypovalvae broad, not quite reaching the base of the forceps; ventral valves long, extending well beyond the base of the forceps; at the base of the forceps there is an oblique papilla surmounted by one or two spines. ♀ genitalia: internal skeleton small; axis projecting only a short distance beyond the plate; sides of plate concave; plate broadest posteriorly; posterior margin deeply and broadly incised.

Types (♂, ♀).— Sherbrooke, Quebec (P. A. Begin); ♂ in Museum of Comparative Zoölogy. I have not been able to locate the ♀.

Distribution.— Quebec, New England, New York, New Jersey, District of Columbia, Pennsylvania, Virginia (Falls Church, June 7), western North Carolina, eastern Tennessee, Ohio (Akron, June 27; Cuyahoga, August 10), Michigan, Indiana (Hessville, August 14), Illinois (West Evanston, August 20), Wisconsin (St. Croix, August 15, 1906, J. P. Saunders); June to September.

The wings of this common species are subject to much variation. In most of the specimens inhabiting regions under 2,000 ft. altitude the wing membrane is distinctly yellow, with dark bands; but in the individuals of higher altitudes, the membrane becomes clearer and may be completely colorless, without markings of any degree. The wings in the latter condition resemble those of *maculosa* and *nebulosa*, although they are usually more slender. The prominent papilla at

the base of the forceps enables easy recognition of the male; in specimens from the central states, especially Michigan and Wisconsin, the papilla is broader than in the more eastern ones.

Panorpa elaborata, n. sp.

Figs. 18, 56, 82

Body brown to yellow; anal horn present. Fore wing: length, 9–11 mm.; width, 3–4 mm.; membrane yellow, with brown or black markings; apical band usually interrupted; pterostigmal band often broken at the middle; first basal spot present, second one absent; both marginal spots present; crossveins heavily margined. ♂ genitalia: forceps small, without lobes; hypovalvae straight, not reaching base of forceps; ventral valves short, barely extending beyond base of forceps, but with an elaborate development of spines: a short branch at the base, terminating in a tuft of barbs, and three other tufts of spines at the top. ♀ genitalia: internal skeleton large; axis extending beyond plate for nearly half its length; plate apparently composed of two parts: a small one, with broadly incised posterior margin, and a larger one, more or less rectangular in shape.

Holotype (♂).— Falls Church, Virginia, July 9 (N. Banks); in Museum of Comparative Zoölogy.

Allotype.— Falls Church, Virginia, August 27 (N. Banks); in Museum of Comparative Zoölogy.

Paratypes.— 1 ♂, Hyattsville, Maryland, July; 1 ♂, Carlisle, Pennsylvania, July 9, 1909 (E. Daecke); 1 ♀, Middlesex Co., New Jersey, July 21; 1 ♀, Glencarlyn, Virginia, May 30 (N. Banks); 1 ♂, Glencarlyn, May 9 (N. Banks); 1 ♀, Falls Church, July 13 (N. Banks); 1 ♂, Falls Church, September 6 (N. Banks); all in Museum of Comparative Zoölogy. 1 ♂ Flatbush, Long Island, New York, June 5, 1897 (J. L. Zabrisic); 1 ♂, Flatbush, New York, June 9 (J. L. Zabrisic); 1 ♂, Flatbush, New York, July 18; 1 ♂New Brunswick July 19 (J. A. Grossbeck); all in American Museum of Natural History. 1 ♂, Staten Island New York, July 30 (W. T. Davis); 1 ♂, Glencarlyn, Virginia, July 23 (N. Banks); both in W. T. Davis collection, Staten Island, New York. 1 ♂, 1 ♀, Washington, D. C., June 15, 1913 (R. C. Shannon); in United States National Museum. 1 ♂, Raleigh, North Carolina, June 21–22 (C. S. Brimley); 1 ♀, Raleigh, North Carolina, June 16, 1926 (C. S. Brimley); in collection of the North Carolina department of agriculture; 1 ♀, Long Island, New York; 1 ♀, Fort Montgomery, New York; both in Brooklyn Museum, New York.

1 ♂, Sandusky, Ohio, June 29; 1 ♀, Jamaica, New York, June 24; both in New York State Museum, Albany. 1 ♀, Winnepauch, Connecticut, June 16 (C. W. Johnson); 1 ♀, Rowayton, Connecticut, June 16 (C. W. Johnson); both in Boston Society of Natural History. 1 ♀, Castle Rock, Delaware Co., Pennsylvania, June 10; 1 ♂, Dauphin, Pennsylvania, July 5; 1 ♂, Richmond Hill, Long Island, New York, July 5; all in collection of Pennsylvania department of agriculture, Harrisburg. 1 ♂, Falls Church, Virginia, July 13 (N. Banks); 1 ♂, Falls Church, August 23 (N. Banks); 1 ♀, Falls Church, August 27 (N. Banks); 1 ♂, Castle Rock, Pennsylvania, June 10, 1905; 1 ♀, Arlington Co., Virginia, July 29, 1929 (C. E. Mickel); 1 ♂, Sea Cliff, New York (N. Banks); 1 ♂, Plummer's Island, Maryland, June 28 (N. Banks); all in writer's collection.

Distribution.— Southern New York, southern Connecticut, New Jersey, Pennsylvania, Maryland, Virginia (Fairfax Co.), North Carolina, South Carolina (Clemson College, May, 1929, F. Sherman), Ohio (Sandusky).

Elaborata resembles *rufescens*, and its male genitalia were figured by Esben-Petersen for that species. The peculiar branches and tufts of barbs on the ventral valves are very constant and enable easy recognition of the males. The female can be distinguished from that of *rufescens* by the presence of the two marginal spots, or, of course, by the genitalia. *Elaborata* appears to have a sporadic distribution; it is common on Long Island and New Jersey, but elsewhere rather rare. It does not range as far north as *rufescens*, scarcely entering into New York and New England.

Panorpa robusta, n. sp.

Fig. 21

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 4 mm.; membrane yellow, markings dark brown; apical band slightly broken; pterostigmal band continuous; basal band interrupted; first marginal and first basal spots present; second marginal and second basal absent; crossveins strongly margined. ♂ genitalia: genital bulb slender; forceps slender and uniformly curved; hypovalvae narrow and long, reaching to base of forceps; ventral valves also very thin and elongate; inner margins of bulb with a very slight prominence.

Holotype (♂).— Meredith, South Carolina, May 7, 1926 (O. Cartwright); in Museum of Comparative Zoölogy.

This Panorpa resembles *rufescens* and *elaborata* in wing markings

but the genitalia are entirely different. The long, slender hypovalvae and ventral valves recall those of *banksi* Hine; but the genital bulb is very broad in comparison with that of the latter species, and the forceps are utterly different in shape.

Panorpa isolata, n. sp.

Figs. 22, 45

Body brown to yellow; anal horn present. Fore wing: length, 9–12 mm.; width, 3–4 mm.; membrane yellow, markings usually black; apical band either broken or entire; pterostigmal and basal bands interrupted; first basal spot present, second absent; both marginals usually present; crossveins usually margined, sometimes not. ♂ genitalia: genital bulb slender; forceps slender, only slightly curved; hypovalvae slender, but not reaching to base of forceps, ventral valves elaborate: at the base there is a slight prominence bearing a tuft of barbs; distally the valves seem to bifurcate, each branch bearing tufts of barbs. ♀ genitalia: internal skeleton small and rather broad, the axis projecting beyond the plate for about half its whole length; sides of plate straight; posterior margin with a very deep and broad "U"-shaped incision.

Holotype (♂).— Stone Mt., Georgia, June 2, 1930 (P. W. Fattig); in Museum of Comparative Zoölogy.

Allotype.— Stone Mt., Georgia, June 1, 1930 (P. W. Fattig); in Museum of Comparative Zoölogy.

Paratypes.— 1 ♂, Atlanta Georgia, June 1, 1930 (P. W. Fattig); 2 ♀, Atlanta, June 17, 1929 (P. W. Fattig); 1 ♂, Atlanta, Georgia, June 3, 1930 (P. W. Fattig); 2 ♀, 1 ♂, Stone Mt., Georgia, June 2, 1930 (P. W. Fattig); 1 ♀, Stone Mt., April 23, 1927; 1 ♂, Atlanta, Georgia, June 26, 1930 (P. W. Fattig); 1 ♂, Bryson City, Deep Creek, Smoky Mts., North Carolina, August 27, 1930 (F. M. Carpenter); 2 ♀, Deep Creek, Smoky Mts., North Carolina, August 26, 27, 1930 (F. M. Carpenter); 1 ♀, French Broad River, Tennessee, 5 miles west of North Carolina line, August 30, 1930 (F. M. Carpenter); Nantahala Gorge, North Carolina, 2,000 ft., August 27, 1930 (N. Banks); all in Museum of Comparative Zoölogy. 1 ♂, 1 ♀, Stone Mt., Georgia, June 18, 1930 (P. W. Fattig); in collection J. E. Davis. 1 ♂, Mt. Rest, Pickens Co., South Carolina, July 3, 1926 (F. Sherman); in Clemson College collection. 7 ♂, 22 ♀, Atlanta, Georgia, and Stone Mt., Georgia, June 2–26, 1930 (P. W. Fattig); 2 ♀, Stone Mt., April 23, 1927 (P. W. Farrig); 1 ♀, Stone Mt., May 27, 1927 (P. W. Fattig); 1 ♂, Nantahala, North Carolina, 2,000 ft., August 25, 1930 (F. Car-

penter); 2 ♂, Balsam Gap, Balsam Mts., 3,315 ft., August 23, 24, 1930 (F. Carpenter); 1 ♂, Nantahala Gorge, North Carolina, August 27, 1930 (F. Carpenter); Willets, Smoky Mts., North Carolina, 222 ft., Autust 24, 1930 (F. Carpenter); all in writer's collection.

This species resembles *elaborata* in habitus and wing markings, although the two marginal spots are variable. The genital bulb is more slender than that of *elaborata* and the forceps quite differently shaped; the ventral valves lack the basal branch of *elaborata*.

Panorpa neglecta, n. sp.

Fig. 23

Body brown to yellow; anal horn present. Fore wing: length 13 mm.; width, 3 mm.; membrane yellow, markings black; apical band entire; pterostigmal band continuous and forked posteriorly (in type); first basal spot present, second absent; first marginal present, second absent; crossveins not margined. ♂ genitalia: genital bulb elongate; outer margins of forceps straight, inner margin with a smooth incision; hypovalvae long and very slender, reaching the base of the forceps; ventral valves straight, extending a short distance beyond hypovalvae; inner walls of bulb with large lobes. ♀ unknown.

Holotype.— 1 ♂, Auburn, Alabama, September 19, 1927 (H. Good); in Museum of Comparative Zoölogy.

The wings of this species recall those of *virginica*, but the genitalia are utterly different, especially in the lack of the large lobes on the forceps.

Panorpa braueri, n. sp.

Fig. 26

Body brown to yellow. Fore wing: length, 11–13 mm.; width, 3–4 mm.; membrane yellow, bands black or dark brown; apical band usually interrupted; pterostigmal band and basal band continuous; first basal and both marginal spots present; second basal spot absent; crossveins weakly margined. ♂ genitalia: forceps slender, the distal part narrow and gently curved; hypovalvae short, broad, not reaching to the base of the forceps; ventral valves also short, not extending beyond base of forceps. ♀ genitalia: internal skeleton very small; axis short and broad; plate circular, sides rounded; posterior margin with a very broad and deep incision.

Holotype (♂).— Washington Co., Arkansas, May 21, 1928; in Museum of Comparative Zoölogy.

Allotype.— Washington Co., Arkansas, May 31, 1928; in Museum of Comparative Zoölogy.

Paratypes — 1 ♀, Washington Co., Arkansas, May 21, 1928; in the collection of the Agricultural College, Fayetteville, Arkansas. 1 ♀, Washington Co., May 21, 1928; in the writer's collection.

This insect resembles *elaborata* in appearance, but the genitalia of both sexes are very different in the two species.

Panorpa speciosa, n. sp.

Fig. 25

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 4 mm.; membrane faintly yellow; bands brown; apical band broken, almost divided into two narrow bands; pterostigmal band continuous (in types); basal band interrupted; first basal spot and both marginal spots present; second basal spot absent; crossveins margined. ♂ genitalia: genital bulb rounded; forceps large, outer edge concave, inner edge with a cluster of short spines; hypovalvae broad, broadest at middle, reaching to base of forceps; ventral valves small, extending a little beyond the base of forceps, each with a small branch which arises on the outer side and curves inward. ♀ unknown.

Holotype (♂).— Heyworth, Illinois, August 14, 1909 (A. B. Walcott); in Field Museum, Chicago.

Paratypes.— 1 ♂, Pine Hills, Illinois, September 14, 1883; in Illinois State Museum, Urbana. 1 ♂, Albert Lea, Minnesota, July 10, 1923 (P. L. Keene); in collection University of Minnesota.

This species is apparently a rare one, although it will probably turn up in several of the central states. The wings are marked like those of *elaborata*, but the male genitalia are closest to those of *rufescens*. The bulb is broader, however, the hypovalvae wider, and the ventral valves much larger. There is an imperfect male of this species in the Museum of Comparative Zoölogy labeled "Arizona" in Hagen's writing; this locality is almost certainly an error.

Panorpa dubitans, n. sp.

Fig. 24

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 3 mm.; membrane yellow; bands and spots light brown; all bands interrupted; first basal spot well developed, second absent; first and second marginal spots present; crossveins faintly margined. ♂ genitalia: genital bulb rounded, much like that of *rufescens;* forceps small,

without lobes; hypovalvae slender and very short, extending a little beyond the middle of the bulb; ventral valves short, but extending a little beyond the base of the forceps; ventral valves with three tufts of barbs, two at the base, directed inwards and upwards, and one nearer the top, directed outwards; beyond the last tuft the stem of the ventral valves is much narrowed; inner walls of bulb with a large lobe. ♀ unknown.

Holotype (♂).— Hessville, Indiana, July 5, 1926 (W. J. Gerhard); in Field Museum, Chicago.

This species is closest to *elaborata;* it can be distinguished by the short hypovalvae and the more elaborate ventral valves.

Panorpa interrupta Banks

Figs. 27, 53

Panorpa interrupta Banks, 1918, Bull. M. C. Z., **62** (1), p. 18.

Body yellow to light brown; anal horn present. Fore wing: length, 10 mm.; width, 3 mm.; membrane yellowish, sometimes colorless; bands brown; apical band broken by clear spots, often reduced to a slight darkening of the apex of the wing; pterostigmal and basal bands interrupted, sometimes reduced to a row of spots; first basal spots present, second absent; first marginal spot present, second absent; crossveins margined. ♂ genitalia: genital forceps broad at base and bearing a small toothed lobe; hypovalvae slender, not reaching base of forceps; ventral valves large, broad, without barbs, and curved toward each other distally; inner wall of bulb with prominent lobes. ♀ genitalia: internal skeleton very small, elongate; axis confined to plate; sides of plate slightly convex; posterior margin deeply and narrowly incised.

Cotypes (♂).— Raleigh, North Carolina, late September (F. Sherman); in Museum of Comparative Zoölogy.

Allotype, by present designation.— Raleigh, North Carolina, May 25, 1922 (C. S. Brimley); in Museum of Comparative Zoölogy.

Distribution.— North Carolina (Raleigh, McCullers, Swannanoa, Havelock, Hendersonville); May to middle of June, and late August to late October.

This is the commonest Panorpa in the vicinity of Raleigh and the Black Mts., but it does not inhabit very high altitudes. The wing markings are nearly as variable as those of *canadensis,* although the altitude is not a factor here. Some specimens have nearly colorless wings, with the bands reduced to spots, while others have distinctly yellow wings, and almost complete bands. The genitalia are very

unusual in both sexes; those of the male are probably nearest to the ones in *carolinensis*, but the internal skeleton of the female is utterly different from that of all the other Panorpas.

Panorpa decorata, n. sp.

Fig. 28

Body brown; anal horn present. Fore wing: length, 10 mm.; width, 3 mm.; membrane light yellow, markings brown; apical band broken by spots, almost divided into two narrow bands; pterostigmal band continuous, much narrowed at middle; basal band interrupted; first basal spot well developed, second one absent; both marginal spots present; crossveins slightly margined. ♂ genitalia: bulb broad, rounded; forceps very short, irregular in shape, a prominent lip on inner margin; hypovalvae short and narrow; ventral valves long, each with four tufts of spines or barbs, all directed inwards and upwards: the lower one long, the next two short, and the last largest; inner margins of bulb with large lobes. ♀ unknown.

Holotype (♂).—Dauphin, Pennsylvania, July 4; in Museum of Comparative Zoölogy.

This peculiar scorpion-fly resembles *elaborata* somewhat, but the forceps and ventral valves are unique.

Panorpa anomala, n. sp.

Fig. 29

Body brown to yellow; anal horn present. Fore wing: length, 11 mm.; width, 4 mm.; membrane faintly yellow; markings dark brown or black; apical band entire or somewhat broken; pterostigmal and basal bands interrupted; first basal spot well developed; second very weak, if present at all; both marginal spots present; crossveins margined. ♂ genitalia: bulb rounded; forceps small, strongly curved distally, with a prominent tooth on the inner margin; hypovalvae short, terminating well below the base of the forceps, and broadened distally; ventral valves very elaborate, each consisting of two branches; the outer one strongly curved and forked at its tip, the inner more nearly straight; neither branch extends beyond the base of the forceps. ♀ genitalia: internal skeleton small, shaped like that of *venosa*, but with a smaller plate; anterior part of plate in the form of a half-moon.

Holotype (♂).—Leavenworth Co., Kansas, June 28, 1924 (R. H. Beamer); in Museum of Comparative Zoölogy.

Allotype.— Same locality, date, and collector; in Museum of Comparative Zoölogy.

Paratypes.— 2 ♀, Baldwin, Kansas, June 17, 1906 (J. C. Bridwell); in collection of J. E. Davis. 1 ♀, Baldwin, Kansas, June 17, 1906 (J. C. Bridwell); in writer's collection.

This species resembles *elaborata* and *rufescens* in general appearance; the female genital plate is much like that of *elaborata*, but the male genitalia are unique in the possession of the long branches on the ventral valves. This is almost certainly the species which Smith called *confusa* in his list of the Mecoptera of Kansas (1925), although I have not seen the specimens which he mentions. *Rufescens* (*confusa*) is a coastal species and has not been collected in the central states, except on the border of the Great Lakes. *Anomala* probably occurs in several of the central states; I have seen an imperfect female from Starved Rock, Illinois, June 13, 1928 (T. H. Frison), in the collection of the Illinois State Museum.

Panorpa dissimilis, n. sp.

Fig. 31

Body brown to yellow; anal horn present. Fore wing: length, 10–12 mm.; width, 3–4 mm.; membrane yellow, markings brown; apical broken; pterostigmal band interrupted at middle; basal band usually broken at several places; first basal spot well developed, second absent; first marginal spot present, second one absent; crossveins heavily margined. ♂ genitalia: forceps large, with an abrupt curve distally; inner margin of forceps with a deep indentation; a very small lobe is usually visible near the middle of the forceps, on the inner surface; hypovalvae short, not reaching the base of the forceps; ventral valves long, reaching well up between forceps; a compact cluster of spines or barbs at the inner base of the valves; inner walls of the bulb with a small lobe. ♀ unknown.

Holotype (♂).— Falls Church, Virginia, July 3 (N. Banks); in Museum of Comparative Zoölogy.

Paratypes.— 1 ♂, Middlesex Co., New Jersey, August 3; in Museum of Comparative Zoölogy. 1 ♂, Staten Island, New York, June 24 (W. T. Davis); in collection of W. T. Davis, Staten Island 1 ♂, Middlesex Co., New Jersey, June 4; in American Museum of Natural History. 1 ♂, Glencarlyn, Virginia, May 29 (N. Banks); in writer's collection.

This peculiar species resembles *rufescens* in appearance, although the wings have a more spotted aspect. The indentation on the forceps, and especially the cluster of barbs at the base of the ventral valves, are unique among all the North American Panorpas.

Panorpa proximata, n. sp.

Fig. 32

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 3 mm.; membrane colorless or nearly so, markings light brown; apical band much reduced, nearly as much as in some *maculosa;* pterostigmal and basal bands also interrupted; first basal spot, and both marginal spots present, second basal absent; second marginal elongate, extending upwards and fusing with top of basal band; crossveins strongly margined. ♂ genitalia: forceps rather short and broad; hypovalvae small, not reaching beyond the top of the lobe on the inner margins of the bulb; ventral valves short, not extending beyond base of forceps, but well developed, terminating in two branches; one short, the other curved and possessing two sets of bristles, perpendicular to each other. ♀ unknown.

Holotype (♂).— Washington Co., Arkansas, May 21, 1928; in Museum of Comparative Zoölogy.

The wings of this species approach those of *chelata* more closely than any other species, although the membrane is a little clearer, and the bands better developed. The male genitalia are very different, however, the ventral valves being most unusual.

Panorpa gracilis, n. sp.

Fig. 33

Body brown; anal horn present. Fore wing: length, 11 mm.; width, 3.5 mm.; membrane faint yellow, markings dark brown; all bands reduced to a series of spots; first marginal and first basal spots present; second marginal and second basal spots absent; crossveins heavily margined. ♂ genitalia: forceps broad, the apices short and abruptly curved; inner margin of forceps deeply concave; hypovalvae not reaching base of forceps, broadened distally; ventral valves slender, without barbs and curved towards each other, usually wrapped around the interior of the bulb. ♀ unknown.

Holotype (♂).— Tarboro, North Carolina, May 8, 1924 (W. B. Mabee); in Museum of Comparative Zoölogy.

Paratype.— 1 ♂, Tarboro, North Carolina, April 26, 1924 (W. B. Mabee); in collection of North Carolina department of agriculture, Raleigh.

The genital bulb of this species is closest to that of *interrupta*, but it is broader; the forceps are utterly different and the hypovalvae are longer, more slender and decidedly more curved.

Panorpa claripennis Hine

Figs. 39, 47, 85

Panorpa claripennis Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 252, pl. 60, fig. 14; pl. 61, fig. 36. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 70.

Body brown to yellow; anal horn present. Fore wing: membrane colorless, spots usually dark brown, sometimes gray; apical band fully developed usually, but sometimes reduced to a series of spots; pterostigmal band usually continuous, but broken in some specimens; basal band usually reduced to a row of spots; first basal spot normally absent, very small if present; both marginal spots and the second basal spot absent; crossveins narrowly margined. ♂ genitalia: forceps small, with a prominent outward bend apically; hypovalvae short and broad, not reaching to the base of the forceps; ventral valves somewhat slender, extending between forceps; inner walls of bulb with a large projection. ♀ genitalia: internal skeleton small, the axis projecting only slightly beyond plate; plate triangular, pointed posteriorly; posterior margin with a deep, narrow incision; anterior margin rounded.

Holotype (♂).— Sherbrooke, Quebec; in Museum of Comparative Zoölogy.

Allotype, by present designation.— Mt. Equinox, Vermont, June 5, 1910 (C. W. Johnson); in Museum of Comparative Zoölogy.

Distribution.— Quebec, New Hampshire, Vermont, New York, Connecticut, Michigan (Ann Arbor, May 28, June 6); early June to early July.

Claripennis is a northern species, resembling *latipennis* Hine, which extends southward into the Carolina mountains. It is apparently single-brooded, and, unlike our other Panorpas, disappears by the middle of July.

Panorpa nebulosa Westwood

Figs. 35, 65, 86

Panorpa nebulosa Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 191. Hagen, 1861, Syn. Neurop. N. A., p. 243. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 247, pl. 60, fig. 21. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 61, fig. 67 (not fig. 66).

Body yellow to light brown; anal horn absent. Fore wing: length, 10–11 mm.; width, 3 mm.; membrane colorless, spots light brown; all three bands reduced to spots or entirely missing; first basal spot present, second basal and both marginal spots absent; crossveins broadly margined with light brown. ♂ genitalia: forceps slender; hypovalvae slender, broadest at middle, not reaching base of forceps; ventral valves long and well developed, usually curved inwards; a small group of thin spines at the base of the forceps; inner walls of bulb with lobes. ♀ genitalia: internal skeleton large; axis large, projecting only a short distance beyond plate, divergent; posterior part of axis projecting beyond plate; anterior margin of plate with a large, semicircular incision.

Type (♀?).— "America boreali" (Doubleday); in British Museum.

Distribution.— Maine (Bar Harbor, August 2, 1910, C. W. Johnson), New Hampshire, Vermont, Massachusetts, Connecticut, New York, northern New Jersey, Pennsylvania, western North Carolina, South Carolina (Caesar's Head, May 30, F. Sherman), Ohio (Columbus, May 28, 1925, R. H. Painter), Michigan (Detroit, Huron Co., Otsego Co.), Illinois (Chicago, Savannah, June 11, 1917), Wisconsin (Polk Co.), Ontario (Waubamic, July 3); middle of May to late August.

Only one of Westwood's types of this species is left in the British Museum collection, and this without an abdomen. Unfortunately the wings are just like those of *maculosa* Hagen, as well as those of a couple of other more rare species described below. Since Westwood's description is not sufficient to enable us to recognize just which species he had, it is impossible for us to identify his insect without knowledge of the genital structure. Obviously there are two courses which we might pursue: we can ignore Westwood's name on the grounds that his species is not recognizable; or we can designate one of our species that fits his description as *nebulosa*. There are two very common Panorpas which fit Westwood's description; one of these, *maculosa*, was described by Hagen, the type being in the Museum of Comparative Zoölogy. I do not believe there is much chance that *maculosa* is the same as *nebu-*

losa, for Hagen had seen Westwood's type of the latter species. The second common Panorpa has been called both *nebulosa* and *maculosa* by various authors; Esben-Petersen figured the genitalia of this species as *maculosa,* but he also erroneously figured the genitalia of *maculosa* as *nebulosa.* I believe, therefore, that this second common Panorpa which has been so confused with *maculosa* is really Westwood's *nebulosa;* at any rate, I consider it advisable to designate this species as *nebulosa,* rather than drop that name and describe the species under another one.

Hine attempted to separate *nebulosa* from *maculosa* by the length of the subcosta. Since he does not mention in any way the genitalia of the species with which he was dealing, we are unable to determine whether or not he was concerned with those species as indicated above; but at any rate the subcosta is of no value as a specific characteristic, as Esben-Petersen observed in his work on the Selys Longchamps collection. The male genitalia of the two species are very different, as will be noted from a comparison of the figures. The females cannot be separated by the wing markings, but the genital plate provides very good and clear characteristics for determination.

Nebulosa is essentially a northern species, occurring in the south only in the mountains. It is the commonest Panorpa of the spring in the northeastern states.

Panorpa sigmoides, n. sp.

Figs. 37, 66

Body brown to yellow; anal horn absent. Fore wing: length, 12 mm.; width, 3 mm.; membrane colorless, all bands reduced to spots; first basal spot weakly formed; second basal and both marginal spots absent; crossveins margined. ♂ genitalia: bulb long and slender, forceps linear, curved only at apex; hypovalvae reaching to bases of forceps, widest distally; ventral valves large, sigmoidal, the tips crossing; inner walls of bulb straight. ♀ genitalia: internal skeleton long and slender; axis extending only a little beyond plate; plate shaped like that of *nebulosa,* but more slender.

Holotype (♂).— Turkey Run, Indiana, June 6, 1926 (K. F. Auden); in Illinois State Natural History Museum, Urbana.

Allotype.— Oakwood, Illinois, June 15, 1930 (H. H. Ross); in Illinois State Natural History Museum.

Paratypes.— 1 ♂, Turkey Run, Indiana, June 30, 1926 (K. F. Auden); 1 ♀, Turkey Run, Indiana, June 20, 1926 (K. F. Auden);

both in Museum of Comparative Zoölogy. 1 ♀, Oakwood, Illinois, June 15, 1930 (H. H. Ross); 4 ♀, Oakwood, Illinois, June 22, 1930 (H. H. Ross); 2 ♀, Oakwood, Illinois, July 13, 1930 (H. H. Ross); 1 ♀, Turkey Run, Indiana, June 6, 1926 (K. F. Auden); 1 ♀, Ravinia, Illinois, July 4, 1907; 1 ♂, Starved Rock, Illinois, June 13, 1928 (T. H. Frison); all in Illinois State Natural History Museum, Urbana. 1 ♂, Oakwood, Illinois, July 13, 1930 (H. H. Ross); 2 ♀, Oakwood, Illinois, June 15, 1930 (H. H. Ross); all in writer's collection.

This peculiar species resembles *nebulosa* in appearance, but the male genitalia are very unusual. The sigmoidal shape of the ventral valves is constant and is unique among our other Panorpas. The female genital plate is close to that of *nebulosa*, but more slender.

Panorpa chelata, n. sp.

Figs. 36, 63

Body brown to yellow; anal horn present. Fore wing: length, 12 mm.; width, 3 mm.; membrane faintly yellow, markings dark brown; apical band narrow, broken; pterostigmal band incomplete posteriorly, basal band interrupted at middle; first basal spot well developed, second basal spot absent; first marginal spot present or absent; second marginal spot absent; crossveins strongly margined, the wings having a spotted appearance. ♂ genitalia: genital bulb very slender, elongate; forceps proportionally very small; hypovalvae long, slender, just reaching to the base of the forceps; ventral valves relatively short, reaching beyond the hypovalvae, but not extending halfway between the forceps. ♀ genitalia: internal skeleton very slender and elongate; axis extending beyond plate for about a third its total length; sides of plate quite straight or very slightly convex; posterior margin with a narrow but deep incision.

Holotype (♂).— Wollaston, Massachusetts, June 12, 1897 (F. H. Sprague); in Museum of Comparative Zoölogy.

Allotype.— Birmingham, Michigan, July 10, 1927 (N. K. Bigelow); in Museum of Zoölogy, University of Michigan.

Paratypes.— 1 ♀, Birmingham, Michigan, July 10, 1927 (N. K. Bigelow); in Museum of Comparative Zoölogy. 2 ♂, Black Rock, Raburn Co., Georgia, 3,500 ft., June 25, 1911; in Cornell University collection. 1 ♂, Carmell, Connecticut, June 23, 1902 (E. S. Morse); in collection of Connecticut Agricultural Experiment Station, New Haven. 1 ♂, Lake Toxaway, North Carolina (A. T. Slosson); in American Museum of Natural History. 1 ♂, Oregon, Illinois, June 28,

1928; in Illinois Natural History Museum, Urbana. 1 ♂, Yaphank, New York, June 20 (G. P. Engelhardt); in collection of J. E. Davis, Alsea, Oregon. 1 ♂, Staten Island, New York, June 23, 1906 (W. T. Davis); 1 ♂, Birmingham, Michigan, July 10, 1927 (N. K. Bigelow); both in writer's collection.

This widely distributed species is distinguished by the elongate genital bulb, with its relatively short forceps. The wings are distinctly spotted, rather than banded, and resemble those of *dissimilis*. Judging from the few records of the species already known to us, *chelata* is as widely distributed as any of our Panorpas. In the collection of the University of Minnesota there is a male labeled "Maine," the only specimen which I have seen from that state.

Panorpa banksi Hine

Fig. 30

Panorpa affinis Banks (*nec* Leach), 1895, Trans. Ent. Soc. Amer., **22**, p. 315.
Panorpa banksi Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 247, pl. 61, fig. 28.
Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 63.

Body yellow to brown; anal horn absent. Fore wing: length, 11 mm.; width, 3 mm.; membrane faintly yellow, markings brown; apical band very small, the other bands reduced to a series of irregular spots; first basal spot well developed, second one absent; both marginal spots absent; crossveins very heavily margined, giving the wing a spotted appearance. ♂ genitalia: genital bulb very slender and elongate; forceps linear, but abruptly curved distally; inner margin of forceps with a shallow incision; hypovalvae slender, reaching nearly to base of forceps; ventral valves long and straight, extending well beyond base of forceps. ♀ unknown.

Holotype (♂).— Sea Cliff, New York; in Museum of Comparative Zoölogy.

In addition to the type, I have seen two other males of this interesting species from South Carolina, collected by Professor F. Sherman at Rocky Bottom (Pickens Co.), June 16, 1928. One of these specimens is now in the writer's collection, and the other in the collection of the South Carolina department of agriculture. The insect is obviously a rare one. The wings are spotted rather than banded and look much like those of *chelata*, n. sp., which is readily distinguished by the reduced forceps. The genital bulb of *banksi* is more like that of *neglecta*, n. sp., but the forceps and the inner walls of the bulb are quite differently shaped.

PANORPA ACUTA, n. sp.

Fig. 38; text-fig. 2c

Body yellow to light brown; anal horn absent. Fore wing: length, 11–12 mm.; width, 3.5 mm.; membrane colorless; all bands reduced to spots, usually brown, sometimes gray; first basal spot weakly formed; second basal and both marginal spots absent; crossveins margined. ♂ genitalia: forceps rather slender, curved abruptly; hypovalvae not reaching to the bases of the forceps, broadest basally, but abruptly narrowed distally; ventral valves slender; inner walls of bulb with prominent lobes; preëpiproct truncate, without lobes. ♀ unknown.

Holotype (♂).— Smoky Mts., Tennessee, near Newfound Gap, 3,500 ft., September 1, 1930 (F. M. Carpenter); in Museum of Comparative Zoölogy.

Paratypes.— 1 ♂, Mt. Meadows, North Carolina, June (N. Banks); 1 ♂, Blowing Rock, North Carolina, August 13; both in Museum of Comparative Zoölogy. 1 ♂, Black Mts., North Carolina, May 20 (W. Beutenmuller); in Cornell University collection. 1 ♂, Fall River, Massachusetts, June 17 (J. A. Cuhman); 1 ♂, Brookline, Massachusetts, June 17 (C. W. Johnson); 1 ♂, Jaffrey, New Hampshire, June 7, 1920 (C. W. Johnson); 1 ♂, Jaffrey, New Hampshire, June 15, 1926 (C. W. Johnson); all in Boston Society of Natural History. 1 ♂, Newfoundland, New Jersey, May 26, 1910; 1 ♂, Suffern, New Jersey, July 21, 1928; 1 ♂, Lake Hopatcong, New Jersey, July 5; 1 ♂, Black Mts., North Carolina (W. Beutenmuller); all in the American Museum of Natural History. 3 ♂, North Branford, Connecticut, July 4, 1924 (B H. Walden); in Connecticut Agricultural Experiment Station. 1 ♂ Linville Falls, North Carolina, late May, 1920 (C. S. Brimley); 1 ♂, Watauga Co., early May, 1917 (F. Sherman); 2 ♂, Sunburst, Haywood Co., North Carolina, late May, 1913; 2 ♂, Highlands, North Carolina, July 7, 1906 (F. Sherman); 1 ♂, Nellie, North Carolina, 3,000 ft., June, 1924 (F. Sherman); 1 ♂, Craggy Mts., North Carolina, June 8, 1916 (R. W Leiby); 1 ♂, Hendersonville, North Carolina, June, 1907 (F. Sherman); all in the collection of the North Carolina department of agriculture, Raleigh. 1 ♂, Warrensburg, New York, June 29 1926; 1 ♂, Poestenkill, New York, June 25, 1926; both in New York State Museum, Albany. 1 ♂, Blue Hills, Massachusetts, June 3, 1916; 1 ♂, Delaware Water Gap, New York, July 9; 1 ♂, Glen House, White Mts., New Hampshire, June 15, 1916 (C. W. Johnson); 1 ♂, Sunburst, North Carolina, late May, 1912 (F. Sherman); 1 ♂, Pittsfield, Massa-

chusetts, July 13, 1929 (F. Carpenter); 1 ♂, Boylston, Massachusetts, June 15, 1930 (F. Carpenter); all in the writer's collection.

Distribution.— Massachusetts, New Hampshire, New York, Connecticut, New Jersey, Pennsylvania (Enola, June 12), West Virginia (Aurora), western North Carolina; May to August.

This species is close to *nebulosa*. The genital forceps are not so slender as those of the latter, the spines at the base of the forceps are reduced, the ventral valves are more slender, and the hypovalvae more pointed. These are minor differences, however, and I would hesitate to describe this as a new species if it were not for the peculiar structure of the preëpiproct. In all of our Panorpas except those of the *lugubris* group, the posterior border of the preëpiproct possesses a pair of tubular lobes; in *acuta* alone these lobes are always absent, the margin being perfectly straight. Since this trait is always associated with the pointed hypovalvae, and the other characteristics mentioned above, there can be no doubt that we are dealing with a distinct species.

Acuta is apparently confined to the eastern states, but it is not a common species and may turn up in some of the more central states. Although I have seen over 75 males from scattered localities, I am not yet certain of the female. The wings, of course, are like those of *nebulosa* and none of the females which I have taken in localities where the males of *acuta* occurred had a genital structure differing from that of *nebulosa*. It is possible that the genital plate of the female of *acuta* is like that of *nebulosa;* but, if so, this is the first instance of the kind which I have found.

Panorpa maculosa Hagen

Figs. 40, 46

Panorpa maculosa Hagen, 1861, Syn. Neurop. N. A., p. 245. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 247, pl. 59, fig. 6. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 62, fig. 66 (not fig. 67).

Body brown to yellow; anal horn absent. Fore wing: length 12–14 mm.; width, 3.5–4.5 mm.; membrane colorless, spots light brown to dark brown, sometimes gray; no complete bands on wing; first basal spot present; second basal and both marginal spots absent; crossveins usually strongly margined, but occasionally the veins may be clear and the wing without spots. ♂ genitalia: bulb slender; forceps long, and tapering, with uniform curvature and a prominent tooth at the base; interior of bulb projecting upwards between the forceps; hypovalvae slender, but short, not reaching the bases of the forceps;

ventral valves slender and long, reaching to the tooth on the forceps. ♀ genitalia: internal skeleton minute and weakly chitinized; axis almost absent; plate circular, with a semicircular incision on the posterior margin.

Types (♂ ♀).— Pennsylvania, 1858 (Uhler); in Museum of Comparative Zoölogy.

Distribution.— Massachusetts, New York, Connecticut, New Jersey, Pennsylvania, Virginia (Fairfax Co.), Ohio (Columbus, May 28, 1925, R. H. Painter; Salinville); western North Carolina, South Carolina (Caesar's Head, May 30, 1926, F. Sherman), Tennessee (Rock Mt., Cumberland Co.), Georgia (Clayton, May 18, 2,000 ft.); late May to middle of August.

This species resembles *nebulosa* and *acuta* and its wings undergo the same variation as those of the other two species. The female genital plate is more reduced than that of any other Panorpa, except the following species, *submaculosa*, n. sp. The projecting interior of the bulb of the male is very striking and unique, although a somewhat similar condition exists in *submaculosa*. Esben-Petersen figured and described *maculosa* as *nebulosa* and *vice versa*.

Panorpa submaculosa, n. sp.

Figs. 41, 60

Body yellow to light brown; anal horn absent. Fore wing: length, 11 mm.; width, 3 mm.; membrane colorless, spots brown or gray; all bands reduced to spots; first basal spot well developed, second basal and both marginal spots absent; crossveins strongly margined. ♂ genitalia: bulb broad; forceps broad with a short, abruptly curved point, and a single tooth at the base, much like that of *maculosa*, only larger; hypovalvae short, not reaching the base of the forceps; ventral valves narrow; interior of bulb extending upwards between the forceps, as in *maculosa*. ♀ genitalia: internal skeleton very small, much like that of *maculosa;* the axis is almost entirely wanting; plate circular, with a broad, semicircular incision on the posterior margin.

Holotype (♂).— Ann Arbor, Michigan, July 8, 1927 (N. K. Bigelow); in Museum of Zoölogy, University of Michigan.

Allotype.— Same locality and date; in Museum of Zoölogy, University of Michigan.

Paratypes.— 3 ♂, 3 ♀, Ann Arbor, Michigan, July 8, 1927 (N. K. Bigelow); 3 ♂, Ann Arbor, Michigan, June 20, 21, 22, 1927 (N. K.

Bigelow); 1 ♂, 1 ♀, Ann Arbor, Michigan, July 25, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, July 1, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, June 2, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, July 27, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, June 26, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, June 4, 1927 (N. K. Bigelow); 2 ♀, Antrim Co., Michigan, July 20, 1923 (T. H. Hubbell); 1 ♀, Wastenau Co., White's Woods, Michigan, June 13, 1921; all in Museum of Zoölogy, University of Michigan. 1 ♂, Port Austin, Huron Co., Michigan, July 6, 1929 (F. M. Gaige); 1 ♂, 1 ♀, Ann Arbor, Michigan, June 22, 1927 (N. H. Bigelow); 2 ♀, Ann Arbor, Michigan, June 27, 28, 1927 (N. K. Bigelow); all in Museum of Comparative Zoölogy. 1 ♂, Ann Arbor, Michigan, June 22, 1927 (N. K. Bigelow); 1 ♂, Ann Arbor, Michigan, May 29, 1918 (F. M. Gaige); 1 ♂, Antrim Co., Michigan, July 20, 1923 (T. H. Hubbell); 1 ♂, Wastenau Co., Michigan, June 13, 1921; 3 ♀, Ann Arbor, Michigan, July 8, 1927 (N. K. Bigelow); 1 ♀, Ann Arbor, Michigan, June 16, 1927 (N. K. Bigelow); 1 ♀, Montmorency Co., Michigan, July 14, 1923 (T. H. Hubbell); all in writer's collection. 1 ♂, Corinth, New York, June 2, 1916 (D. B. Young); in New York State Museum, Albany.

This interesting scorpion-fly has the same habitus as *maculosa*, and the genital bulb is similar, aside from the forceps. The latter are unusually broad, whereas those of *maculosa* are unusually slender. The female genital plates in the two species are similar in size, but are quite differently shaped.

Panorpa latipennis Hine

Figs. 34, 64

Panorpa latipennis Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 248, pl. 59, figs. 1, 3; pl. 61, fig. 32. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 63.

Panorpa longipennis Banks, 1911, Trans. Ent. Soc. Amer., **37**, p. 349.

Body brown to yellow; anal horn absent. Fore wing: length, 13–15 mm.; width, 3–4 mm.; membrane colorless; spots brown or gray; all bands usually reduced to spots, though occasionally the pterostigmal band is continuous; first basal spot present usually, second basal and both marginal spots absent; sometimes all markings on the wing are lost; crossveins usually margined. ♂ genitalia: forceps linear, curved at the tips only, with a very small lobe; hypovalvae short, not reaching to the base of the forceps; ventral valves short, widely separated,

reaching to the base of the forceps; inner walls of bulb with a very large lobe. ♀ genitalia: internal skeleton large, axis projecting some distance beyond plate; plate broadened distally; posterior margin with a deep and narrow incision; anterior to the plate there is another thin chitinous plate in the form of a "U."

Cotypes (♂ ♀).— 1 ♂, 1 ♀, Detroit, Michigan, June 2 (Hubbard and Schwarz); both in United States National Museum. 1 ♀, Sea Cliff, Long Island, New York (N. Banks); in Museum of Comparative Zoölogy.

Distribution.— Vermont (Mt. Equinox, June 5, C. W. Johnson); New York, Massachusetts, Connecticut (Litchfield, June 14), New Jersey (Ramsey, July 10), western North Carolina; late May to middle of July, in the north; June and July in North Carolina.

The wings of this species usually resemble those of *claripennis*, but sometimes they are entirely without markings. The male genitalia are unlike those of *claripennis*, however; the small lobe on the forceps of *latipennis* is a fine distinguishing feature. The shape of the wings of *latipennis* is unusually variable; in some specimens, especially those from North Carolina, the wings are slender, while in others they are fully as broad as those of *claripennis*. Banks' *longipennis* was based on a female from North Carolina with slender wings; the type specimen, which is in the Museum of Comparative Zoölogy, has the same internal skeleton as the females of *latipennis*.

BITTACIDAE

Ocelli present; labial palpi two-segmented; abdomen cylindrical; females without ovipositor; terminal segments of male only slightly modified; legs tenuate, with a single tarsal claw, modified for grasping; wings usually subpetiolate, slender; costal space narrow, with few crossveins; Rs arising at about one-half the wing length from the base; M dividing near the middle of the wing.

All the North American species of the family belong to the genus Bittacus, except the wingless *apterus* MacLachlan, which has been placed in a distinct genus, Apterobittacus.

Bittacus Latreille

Bittacus Latreille, 1805, Hist. Nat. Crust. Ins., **8**, p. 20. Klug, 1836, Abh. Köngl. Akad. Wiss. Berlin, p. 97. Rambur, 1842, Hist. Nat. Ins. Neurop., p. 326. Hine, 1898, Journ. Columb. Hort. Soc., **12**, p. 108. Miyaké, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, **4** (6), p. 383. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 117.

Leptobittacus Hine, Journ. Columb. Hort. Soc., **12**, p. 108.

Eyes widely separated below antennae, basal segment of hind tarsus longer than fourth segment; wings present, without bands; one costal cross-vein; 1A of hind wing coalescing with Cu2 for a short distance only.

This is the most widely distributed genus of Mecoptera, although it contains only about fifty species. In the New World it occurs rather sporadically. It is best represented in central and eastern United States; one species occurs in California, but none have been taken in the northwest or in the Rocky Mountain States. The northern limit of the genus in our area seems to be along the southern shores of the Great Lakes. Southward, it extends across Central America and down into Chile.

In general habitus the adults of Bittacus resemble tipulids, regardless of the presence of hind wings. Their flight also recalls that of the tipulids, but their position at rest is very different. They usually hang suspended from the under surface of leaves or twigs, with the wings held together over the abdomen. They are not nearly so alert as the Panorpas and are easily captured, although they are essentially predaceous. The exceedingly long legs compensate in a measure for their slow flight. I have never seen a specimen seize its prey while flying; it usually remains immobile under a leaf for many minutes or even hours until a smaller insect alights within reach of its legs. Then it reaches out and grasps the victim with the jaw formed by the bending of the tarsus. When the captured insect has been turned or twisted into a satisfactory position, it is carried within reach of the beak, which usually penetrates between the abdominal segments or at the junction of the head and thorax. In all probability the fluids of the body alone are consumed. Soft-bodied insects, like the Diptera, are undoubtedly preferred as food, but Hymenoptera, Hemiptera, Lepidoptera, and even Coleoptera are frequently taken as well. Miyaké (1913) has observed that the Japanese Bittacus will feed on dead insects, decayed leaves, soil, and drops of water.

Bittacus, even more than Panorpa, is inclined to be local in its oc-

currence. In the eastern states the species usually inhabit moist, damp woods, but in the central parts of the country, especially Kansas, they may be found along the dry and dusty roads. Less is known of the life history of Bittacus than of Panorpa. No one has ever secured the larva or pupa of an American species; and Brauer (1863) alone has succeeded in rearing adults through all the stages. The following account of the life history is based upon his observations on *B. italicus* Müll. and *B. hageni* Brauer. The eggs are laid in small clusters within the soil during the fall and remain over winter in that condition. If the soil in the egg chamber dries up in the late fall, the eggs hatch the following April; but if the soil stays moist, the eggs remain over until the spring of the second year following (according to Brauer). The larvae live above the ground among the leaves and grass, not in the soil like Panorpa. Brauer fed his larvae on raw meat, but he did not determine the natural feeding habits. The larvae are more spiny than those of Panorpa and are stouter. They are also more active than the Panorpa larvae; when frightened or disturbed they roll up in the manner so characteristic of certain caterpillars, or they throw the anterior part of the body in an erect position, much like the sphingid larvae. About ten days before pupation the larvae bury themselves in the soil and form a small chamber. The pupae are similar to those of Panorpa and require about two weeks for the development of the adult. Brauer states that the adult of *B. italicus* forms a chamber of leaves and twigs, and lives within, feeding on the insects which are unfortunate enough to enter. No such chamber has been observed in the case of the American species and I am certain that none is used by *B. strigosus*. Only a few, generalized descriptions have been made of the mating habits of Bittacus; I have only been able to observe courtship in *strigosus* and have not seen any indication of the elaborate behavior recorded above in some Panorpas.

In the classification of the species of Bittacus, we are able to use not only the male genitalia, but certain antennal features, body and wing coloration, and even venation. Esben-Petersen has employed numerous venational peculiarities, but from a detailed study of several thousand specimens of our species, I am obliged to regard some of these characteristics as a matter of individual variation only. There are three venational features, however, which are of use and value in the determination of our species, especially the females: the presence or absence of the *apical crossvein* (text-fig. 4, Av.); the position of the *subcostal crossvein* (Scv) with respect to the first fork of Rs (Frs); and the number of pterostigmal crossveins (Pcv). The male genital appa-

ratus is not so complex as that of Panorpa, and the parts used in classification are easily seen (fig. 67). In place of the forceps of Panorpa there are two dorsal lobes, the *copulobi* (cl); ventrally there are two fused plates,

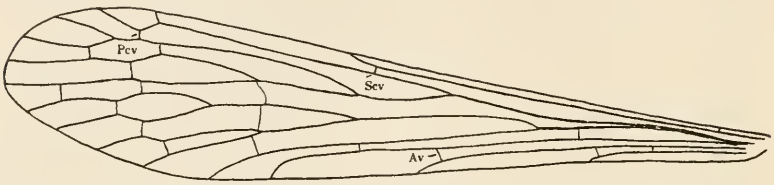

Fig. 5.— Fore wing of Bittacus: Pcv, pterostigmal crossvein; Scv, subcostal crossvein; Av, anal crossvein.

the *paraprocts* (pa); extending from the paraprocts there are two hooks, the *penunci* (pu), which usually bear a spiral filament (sf); the cerci appear as a pair of curved, slender lobes between the *copulobi* and *paraprocts;* the *epiproct* (sa) is a median plate usually included between the two *copulobi*. The females of Bittacus seem to have lost the internal skeleton which is so prominent and useful in the taxonomy of the Panorpas; but the body and wing characteristics in Bittacus are sufficient for the satisfactory determination of the specimens of this sex.

Key to the Species of Bittacus

1. Apex of wings darkened (fig. 87) ..... *apicalis*
   Wings uniform in color 2
2. Apical crossvein present 3
   Apical crossvein absent 4
3. Hind femur with black or dark brown spots at base of hairs; antennae with short pile (fig. 71) ..... *punctiger*
   Hind femur without spots; antennae with long pile (fig. 75). *pilicornis*
4. Subcostal crossvein placed distad of first radial sector fork (fig. 68). *occidentis*
   Subcostal crossvein placed basad of first radial sector fork 5
5. Wings dark brown (fig. 70) ..... *texanus*
   Wings colorless or yellow 6
6. Wings very long and slender (fig. 88) ..... *chlorostigma*
   Wings relatively broad 7
7. Wing membrane colorless; crossveins margined (fig. 89) ... *strigosus*
   Wing membrane yellow; crossveins not margined (fig. 69). *stigmaterus*

Bittacus apicalis Hagen

Figs. 67, 87

Bittacus apicalis Hagen, 1861, Syn. Neurop. N. A., p. 248. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 109, pl. 2, figs. 13, 14. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 255, pl. 60, fig. 15. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 150, fig. 171.

Body yellow to brown; hind tibiae only slightly thickened. Fore wing: length, 13–16 mm.; width, 3–4 mm.; slender, rounded apically; membrane colorless, with a distal dark brown patch at the very apex; Av absent; Scv basad of Frs; 1 Pcv. ♂ genitalia: copulobi only a very little longer than the paraprocts; short, broad, the upper margin slightly concave; cerci short, less than one-half the length of the paraprocts; penunci slender, terminating in a filament.

Types (♂ ♀).— Southern Illinois (Kennicott); in Museum of Comparative Zoölogy.

Distribution.— Illinois, Indiana, Ohio, Michigan, western North Carolina, West Virginia (Ft. Pendleton, September 7), western New York; June to early September. Hine records this species from Arkansas and Virginia, but I have seen no specimens from those states.

Apicalis is common in Michigan and Illinois, but is only rarely found in the eastern states and apparently never reaches the coastal areas. It is easily recognized by the brown patch at the apex of the wing.

Bittacus punctiger Westwood

Fig. 71

Bittacus punctiger Westwood, 1841, Trans. Ent. Soc. Lond., **4**, p. 195. Hagen, 1861, Syn. Neurop. N. A., p. 247. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 113, pl. 2, figs. 9, 10. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 258, pl. 60, fig. 19. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 146, fig. 166.

Body yellow to brown; hind tibiae only slightly swollen, with black or dark brown spots at the bases of the hairs. Fore wing: length, 16–18 mm.; width, 4–5 mm.; broad and rounded apically; membrane yellowish; crossveins margined with brown or gray; a few gray spots placed irregularly near the middle of the wing; Av present; Scv basad of Frs; 2 Pcv. ♂ genitalia: copulobi only about as long as the paraprocts, broadest basally; cerci very long and slender, extending beyond

paraprocts; penunci long and slender, usually coiled; epiproct with a large dorsal branch and a small ventral one.

Types (♂ ♀).— "Georgia"; in British Museum.

Distribution.— Georgia, Virginia, District of Columbia, North Carolina (Mt. Graybeard, May 23; Hertford Co., June 9; Raleigh, June 1, C. S. Brimley), late May to August; Esben-Petersen records this species from Illinois and Texas.

This insect resembles *strigosus* in habitus, but it is readily distinguished by the spots on the hind femora. It is not uncommon in the vicinity of District of Columbia, but elsewhere occurs rarely and sporadically.

Bittacus pilicornis Westwood

Fig. 75

Bittacus pilicornis Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 196. Hagen, 1861, Syn. Neurop. N. A., p. 246. Hine, 1898, Journ. Columb. Hort. Soc., **12**, p. 113, pl. 2, figs. 15, 16. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 261, pl. 60, fig. 17. Esben-Petersen, Coll. Zoöl. Selys Longchamps, **5** (2), p. 170.

Body yellow to brown; hind femora only slightly thickened; antennae with very long pile. Fore wing: length, 18–24 mm.; width, 6–7 mm.; broad and rounded apically; membrane usually yellow, rarely colorless; crossveins margined with brown; Av present; Scv basad of Frs; 2 Pcv. ♂ genitalia: copulobi short, only as long as paraprocts; cerci long and slender, reaching to end of paraprocts; penunci large, terminating in a spiral filament; epiproct very large, the upper branch forked distally and terminating in a cluster of spines.

Types (♂ ♀).— "America septentrionale" (E. Doubleday); in British Museum.

Distribution.— New Hampshire (White Mts., August 15, F. H. Sprague), New York (Ithaca, Old Forge), New Jersey, Pennsylvania (Marysville), Virginia, Maryland, North Carolina, Georgia (Atlanta, June 19, 1930, P. W. Fattig), Ohio (Medina, July 20), Illinois, Indiana (Turkey Run, June 6, 20), Kansas (Baldwin, June 2, 17); May to August. Hine records this species from Michigan and "Canada."

Pilicornis resembles *punctiger* superficially, but can be recognized at once by the very long pile on the antennae.

Bittacus occidentis Walker

Fig. 68

Bittacus occidentis Walker, 1853, Cat. Neurop. Ins. Brit. Museum, p. 469. Hagen, 1861, Syn. Neurop. N. A., p. 247. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 112, pl. 2, figs. 11, 12. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 259, pl. 61, fig. 35. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 145, fig. 165.

Bittacus arizonicus Banks, 1911, Trans. Ent. Soc. Amer., **37**, p. 350, pl. 11, figs. 11, 12. Esben-Peterson, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 146.

Body brown; hind femora of male much swollen. Fore wing: length, 17–20 mm., width 4–5 mm.; slender, somewhat pointed; membrane uniformly smoky brown; crossveins not margined; Av absent; Scv distad of Frs; 2 Pcv. ♂ genitalia: copulobi slender, short, not reaching beyond paraprocts; paraprocts broad; penunci small, tapering; cerci very short; epiproct also small, extending only a little beyond cerci.

Types (♂ ♀).— Erie, Pennsylvania (E. Doubleday); in British Museum.

Distribution.— New York (Brown's Mills, August 31); Maryland, District of Columbia (Washington, October 3, November 12), Virginia (Fairfax Co.), North Carolina (Raleigh, September, October), Arkansas (Rich Mts., Polk Co., 2,600 ft., August 2), Alabama (Auburn, November 1. 1928, H. Good), Texas (Dallas, Brownwood), Arizona (Palmerlee, August), Illinois (Urbana, Champaign), eastern Kansas, Nebraska (Atlantic, July 23, Carmel, July 18); July to November. Hine records this species from Pennsylvania, Indiana, and "Canada."

This Bittacus is similar to *texanus* as far as the as the wings are concerned, but it can be distinguished by the position of Scv, which is distad of Frs, not basad as in all our other species of the genus; also, of course, by the male genitalia. Banks' *arizonicus* (type in the Museum of Comparative Zoölogy) is identical in every respect with *occidentis*. The genital differences which he noted do not exist; the tooth which he mentioned on the inferior median plate is really a piece of foreign matter adhered to the specimen. *Occidentis* has the widest range of all our species of *Bittacus*, and is the only Mecopteron which has been found in Arizona or Nebraska.

Bittacus texanus Banks

Fig. 70

Bittacus texanus Banks, 1908, Trans. Ent. Soc. Amer., **34**, p. 261. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 145.

Body brown, usually dark; hind femora of male much swollen. Fore wing: length, 22 mm.; width, 6 mm.; broadened and well rounded distally; membrane uniformly dark brown; crossveins not margined; Av absent; Scv basad of Frs; 2 Pcv. ♂ genitalia: copulobi nearly twice the length of the paraprocts, broadest basally; paraprocts short and broad; penunci short, filamentous; cerci much longer than paraprocts; epiproct very small, almost concealed.

Holotype (♂).— Plano, Texas, July, 1907 (E. S. Tucker); in Museum of Comparative Zoölogy.

Allotype, by present designation.— Decator, Texas, September 15, 1914 (W. T. Davis); in Museum of Comparative Zoölogy.

This rare species resembles *occidentis* but is much larger; Scv is basad of Frs instead of distad, as in *occidentis*, and, of course, the male genitalia are very different. I have seen only four specimens in addition to the types: 1 ♀, Decator, Texas, September 15 (W. T. Davis); in collection of J. E. Davis. 1 ♂, Decator, September 15; 1 ♀, Citrus Center, Florida, May 2; both in collection of W. T. Davis. 1 ♀, Austin, Texas, October 29; in collection of Kansas State Agricultural College.

Bittacus chlorostigma MacLachlan

Figs. 72, 88

Bittacus chlorostigma McLachlan, 1881, Ent. Mo. Mag., **18**, p. 36, fig. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 110, pl. 1, fig. 8; pl. 2, figs. 3, 4. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 258, pl. 61, fig. 37. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 142, figs. 161, 162.

Harpobittacus chlorostigma MacLachlan, 1893, Ent. Nachr, **19**, p. 317.

Body brown; hind femora only slightly thickened. Fore wing: length, 24–27 mm.; width, 4 mm.; very long and slender; membrane colorless, with a deep yellow pterostigma; crossveins not margined; Av absent; Scv basad of Frs; 2 Pcv. ♂ genitalia: copulobi very large, extending upwards, rather than posteriorly; paraprocts short and broad; penunci broad, not very long; cerci very short; epiproct about as long as the paraprocts

Types (♂) — "South California"; in MacLachlan collection.

Allotype, by present designation.— Amador Co., California; in Museum of Comparative Zoölogy.

Distribution.— Central and southern California. None of the specimens which I have seen are dated.

This remarkable *Bittacus* is readily recognized by its very tenuate wings and the deep yellow pterostigma. The genus *Harpobittacus* was established by Gerstaecker for *australis* Klug, chiefly because the basal metatarsal segment was apparently much shorter than the last segment. MacLachlan, however, showed that this was an erroneous description of the tarsal segmentation, for the segment which Gerstaecker supposed to be the last was really the fourth and fifth together. MacLachlan retained the genus *Harpobittacus* because the tenuity of the wings and a few other characteristics of *australis* seemed to require generic distinction, and he placed *chlorostigma* there. But the tarsal segmentation of *australis* really is quite different from that of *chlorostigma:* the basal segment of the metatarsus in the latter is much longer in the fourth, whereas in the females of *australis* it is only as long as the fourth, and in the males only a very little longer. This is apparently the reason why Esben-Petersen retained *chlorostigma* in *Bittacus*, although he does not give an explanation.

Bittacus strigosus Hagen

Figs. 73, 89

Bittacus strigosus Hagen, 1861, Syn. Neurop. N. A., p. 246. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 262, pl. 59, fig. 9. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 148, fig. 168.

Leptobittacus strigosus Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 115, pl. 1, figs. 1–6, 9–11; pl. 2, figs. 5, 6.

Body brown; hind femora slender in both sexes. Fore wing: length, 17–19 mm.; width, 5–6 mm.; broad, rounded distally; membrane colorless; crossveins strongly margined with gray or brown; Av absent; Scv basad of Frs; 1 or 2 Pcv. ♂ genitalia: copulobi large, about twice as long as paraprocts, and very broad basally, with a ventral tooth; paraprocts small, rounded; cerci very long and broad, extending beyond paraprocts; penunci shaped like an elongate tooth, and giving rise to a thin, coiled filament; epiprocts much reduced, invisible from the side.

Cotypes.— 2 ♂, 1 ♀, Chicago, Illinois; 5 ♀, Washington, D. C.; in Museum of Comparative Zoölogy.

Distribution.— Quebec (Montreal), New Hampshire (Hampton, July 16), Vermont (Woodstock, July), Massachusetts (Pittsfield, July), Connecticut, New York, New Jersey, Pennsylvania, District of Columbia, Maryland, Virginia (Fairfax Co.), Ohio, Michigan, Illinois, eastern Kansas, Minnesota; late May to late August. Hine records this insect from Missouri and Arkansas, but I am inclined to doubt the latter locality.

This species resembles *punctiger*, but the wing membrane is colorless and the hind femora lack the brown spots which are always present in *punctiger*. In the northeastern states it is the commonest Bittacus, and in New England the only one which occurs regularly. It is frequently excessively abundant over a small area, sometimes covering only an acre, but completely absent in the surrounding country for many miles. I have found one colony of this insect in the vicinity of West Pittsfield, Massachusetts, including about an acre of damp woodland, where four or five specimens can be taken with a single stroke of the collecting net; yet I have failed to find the species anywhere else in the Berkshires.

Bittacus stigmaterus Say

Fig. 69

Bittacus stigmaterus Say, 1823, Western Quart. Reporter, **2**, p. 164. Hagen, 1861, Syn. Neurop. N. A., p. 247. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 114, pl. 1, fig. 7; pl. 2, figs. 7, 8. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 147, fig. 167.

Bittacus pallidipennis Westwood, 1846, Trans. Ent. Soc. Lond., **4**, p. 195.

Body brown; hind femora slender in both sexes. Fore wing: length, 16–23 mm.; width, 4–5 mm.; slender, rounded apically; membrane yellowish, sometimes faintly so; crossveins not margined; Av absent; Scv basad of Frs; 2 Pcv. ♂ genitalia: copulobi elongate, slender, about twice as long as paraprocts; paraprocts rather long; penunci long, with a coiled filament; cerci very long, exceeding paraprocts; epiproct reduced, almost invisible from the side.

Distribution.— Connecticut (New Haven, August 23), New York (Long Island; Ithaca, August 16), Maryland, District of Columbia, Virginia (Fairfax Co., Arlington Co.), North Carolina (Raleigh, July, August, C. S. Brimley), Georgia (Dalton), Ohio, Illinois, Kansas (Manhattan, July; Osborne Co., August; Pottawattomie Co.; Gove Co., August 28, 1927, F. M. Carpenter); April to September. Hine records this species from Missouri.

Westwood's *pallidipennis* was based upon a specimen in the British Museum without locality label; Hagen examined this specimen and recognized it as *stigmaterus*. The Bittacus referred by Hine (1898) to *mexicanus* Klug was really a large *stigmaterus*, as he himself decided later (1901). *Stigmaterus* is a very distinct species; the yellow wings and clear crossveins enable easy recognition.

Apterobittacus MacLachlan

Apterobittacus MacLachlan, 1893, Ent. Nachr., **19**, p. 317. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 108. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 162.

Eyes widely separated below antennae; basal segment of hind tarsus longer than the fourth; wings absent in both sexes.

Genotype.— *Bittacus apterus* MacLachlan.

Apterobittacus apterus MacLachlan

Figs. 79, 90

Bittacus apterus MacLachlan, 1871, Ent. Mo. Mag., **8**, p. 100. Hine, 1898, Journ. Columb. Hort. Soc., **13**, p. 110, pl. 2, figs. 1, 2. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 257, pl. 60, fig. 15.

Apterobittacus apterus MacLachlan, 1893, Ent. Nachr., **19**, p. 317. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 162.

Body dark brown; length, 20–23 mm.; ♂ genitalia: copulobi large, about twice as long as paraprocts, with a concave dorsal margin; paraprocts small, rounded posteriorly; penunci broad basally, tapering; cerci very short, not half the length of the paraprocts; epiproct minute, not visible from the side.

Types (♂ ♀).— Brooklyn, Alameda Co., California, April, 1871 (W. Holden); in MacLachlan collection.

Distribution.— Central California.

This remarkable insect is not uncommon locally in California; sixty specimens were taken in the original collection by Holden, who states (in MacLachlan, 1871) that they "were captured in an area of 15 to 20 feet, under a live oak tree in a patch of thistle and wild mustard. They were most active just after sunset and sunrise, crawling about the stalks of the thistle and mustard, feeding on flies and other small insects. When the plants were shaken they instantly dropped to the ground, and concealed themselves in the grass. The colors when alive

were brighter, the *green* resembling that of the plants on which they were found, so it was not easy to distinguish them unless in motion." The green color mentioned disappears in dried or alcoholic specimens. According to Osten-Sacken (1882) this insect replaces its want of wings by great dexterity in climbing, swinging itself, monkey-like, from twig to twig, often supported by a single tarsus. He once observed a specimen devouring a tipulid with vestigial wings,[1] and he suggests a possible mimicry for this species on the part of the Bittacid.

BOREIDAE

Ocelli present, widely spaced; rostrum long; labial palpi two-segmented, the distal segment very small; abdomen short, stout; female with well developed ovipositor; two smooth tarsal claws; wings rudimentary: in the male they are represented by four slender, chitinous bristles; in the female the hind wings are entirely absent, the fore ones reduced to small oval pads.

This highly specialized family includes the single genus Boreus.

Boreus Latreille

Boreus Latreille, 1825, in Cuvier's Regne Anim., **5**, p. 247. Klug, 1836, Abh. Königl. Akad. Wiss. Berlin, 1836, p. 88. Rambur, 1842, Hist. Nat. Ins. Neurop, p. 328. Fitch, 1847, Amer. Journ. Agr., **5**, p. 278. Hagen, 1861, Syn. Neurop. N. A., p. 240. Hagen, 1866, Ent. Mo. Mag., p. 132. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 240. Esben-Petersen, Coll. Zoöl. Selys Longchamps, **5** (2), p. 108.

This is a small genus of less than a dozen species, scattered over eastern and northern Europe, United States, western Canada, and Alaska. The American species are especially boreal in distribution. In the east only one species (*brumalis*) has been taken as far south as Washington, D. C.; in the west another species (*californicus*) occurs in the Sierra Nevada Mountains of California. Usually the adults are to be seen only in the winter, when on sunny days they hop actively about on the snow. In the spring and early summer they may also be found in moss and even under stones.

The life history of Boreus was first worked out by Brauer (1862); additional observations have been made by William (1916), and more recently Withycombe (1924, 1926) has given a splendid account of the biology of the European species, *B. hyemalis* Linné. Since very

[1]Dr. C. P. Alexander tells me that this tipulid is almost certainly *Tipula vestigipennis* Doane

little is known of the life history of the American species, the following description is based largely on the papers of Brauer and Withycombe. The eggs are laid one or two at a time among moss roots. The larvae hatch in about ten days, usually during December; they possess abdominal prolegs during the first stage (according to Brauer), but lose them later. There are at least four instars, during which the larvae

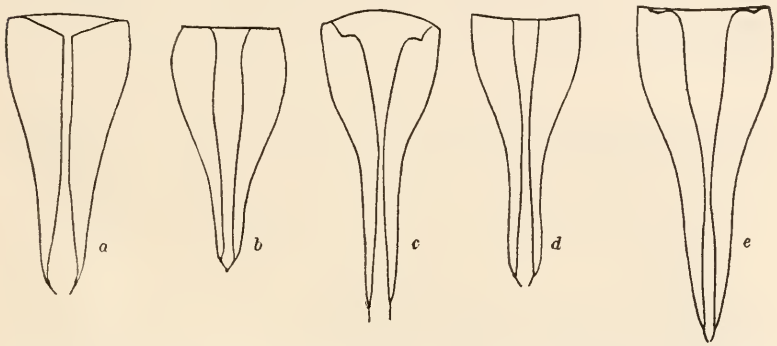

FIG. 6.—Wings of Boreus (♂): a, *nivoriundus;* b, *brumalis;* c, *californicus;* d, *unicolor;* e, *borealis.*

feed on moss roots and liverworts. The full grown larva, usually about 6 or 7 mm. long, is shorter and stouter than that of Panorpa or Bittacus. The larval stage is the longest, lasting from December to August, when the larva prepares for pupation by forming a vertical tube in the soil, nearly extending to the surface. The pupa is more active than the larva, rapidly wriggling up and down the tube when disturbed. After from four to eight weeks the imagines appear. The adults feed on moss and Withycombe kept one specimen alive for over a month on crushed flies, but he believes that only the juices were consumed and that the adults are entirely phytophagous. Mating takes place soon after emergence of the adults. The process of mating is a curious one:[1] the male runs alongside the female and by a series of sudden movements grasps her with his hooked wings near the base of the abdomen and pulls her upon his back. After the male has seized her abdomen in his genital forceps, he releases the hold with his wings and "wanders about on the surface of the ground with the female seated on his back and apparently helpless."

[1] This has been observed in *Boreus hyemalis* by Withycombe (1926), and in *B. californicus* by Cockle (1908).

For the identification of the species of Boreus it is necessary to use a key for each sex, since the males and females can be satisfactorily classified only on secondary sexual characteristics. The males are readily distinguished by the shape of the bristle-like wings; the females, by the relative length of the ovipositors, and by the color of the wing pads, and the body as a whole. The coloration of the various parts of the body is of little taxonomic value because of its instability. The male genitalia are also useless because they are constant in all our species.

Key to the Males of Boreus

1. Posterior margin of hypandrium emarginate ..... *brumalis*
   Posterior margin of hypandrium entire 2
2. Outer margin of wings abruptly curved; inner margin with a deep incision at base ..... *californicus*
   Outer margin of wings smoothly curved; inner margin without basal incision 3
3. Wings broad, almost contiguous basally ..... *nivoriundus*
   Wings narrow, widely separated at base 4
4. Wings yellow ..... *borealis*
   Wings black or very dark brown ..... *unicolor*

Key to the Females of Boreus

1. Ovipositor twice as long as the beak 2
   Ovipositor only about as long as the beak 4
2. Wing pads yellow or very light brown 3
   Wing pads black or very dark brown ..... *unicolor*
3. Eyes gray; abdomen above with fine, gray pilosity ..... *californicus*
   Eyes dark brown or black; abdomen above glabrous ..... *borealis*
4. Body brown, dull ..... *nivoriundus*
   Body black, shiny ..... *brumalis*

Boreus brumalis Fitch

Text-fig. 6b

Boreus brumalis Fitch, 1847, Amer. Journ. Agric., **5**, p. 278. Hagen, 1861, Syn. Neurop. N. A., p. 240. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 255. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 113, pl. 2, fig. 24.

Male.— Length of body, 2–2.5 mm.; dark brown to black, shiny; wings same color as rest of body; vertex shiny, black; wings with the

outer margins smoothly curved; posterior margin of hypandrium emarginate.

Female.— Length of body, 4 mm.; dark brown to black, shiny; wings same color as rest of body; vertex black; ovipositor only about as long as the beak.

Cotypes (♂ ♀).— Eastern New York; in Museum of Comparative Zoölogy.

Distribution.— Massachusetts (Holliston, Tyngsboro, Malden, Cambridge, Sherborn, Weston, Boston), New York (Ithaca, Long Island), District of Columbia, Michigan (Detroit; E. Lansing, February 16); December to February.

This is our smallest Boreus. It can easily be distinguished from the other eastern species (*nivoriundus*) by its black color and shiny appearance.

Boreus nivoriundus Fitch

Text-fig. 6a

Boreus nivoriundus Fitch, 1847, Amer. Journ. Agr., **5**, p. 277. Hagen, 1861, Syn. Neurop. N. A., p. 240. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 254. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 124.

Male.— Length of body, 3.4–4 mm.; dull brown, the wings and legs lighter than the rest of the body; vertex dark brown, shiny; wings broad basally, almost contiguous; posterior margin of hypandrium entire.

Female.— Length of body, 4.5–5 mm.; color similar to that of male; wing pads dull brown; ovipositor only as long as the beak.

Cotypes (♂ ♀).— Eastern New York; in Museum of Comparative Zoölogy.

Distribution.— Maine (Ellsworth), Massachusetts (Roxbury, Malden), New York (Sea Cliff, Bainbridge); December to February.

This is a less common species than *brumalis*, although Fitch found it abundant in New York. It is larger than *brumalis* and distinctly dull brown in color.

Boreus californicus Packard

Text fig. 6c

Boreus californicus Packard, 1871, Proc. Bost. Soc. Nat. Hist., **8**, p. 408. Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 255. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 114.

Male.— Length of body, 3.5–4 mm.; dark brown, somewhat shiny,

bronze; wings light brown or yellow; vertex feebly punctate; eyes gray; outer margin of wings with an abrupt bend near the middle; inner margin of wing at base with a deep incision; posterior margin of hypandrium entire.

Female.— Length of body, 5 mm.; color similar to that of male; wing pads yellow or yellow-brown; ovipositor twice the length of the beak.

Cotypes (♂ ♀).— Ft. Bidwell, Siskiyou, California, 4 ♀, 3 ♂; in Museum of Comparative Zoölogy.

Distribution.— California (Siskiyou Co), Oregon (Moose Lake), Alberta (Sulphur Mt., February 10), British Columbia (Kaslo, December); December to February. Hine records this insect from Pullman, Washington.

This species looks somewhat like an enlarged *brumalis* in general appearance. The female can be distinguished from that of *unicolor* by its yellow wing pads, which are black in *unicolor;* the males can be recognized by the abrupt bend in the outer margin of the wings.

Boreus unicolor Hine

Text-fig 6d

Boreus unicolor Hine, 1901, Bull. Sci. Lab. Den. Univ., **11**, p. 250. Esben-Petersen, 1921, Coll. Zoöl. Selys Longchamps, **5** (2), p. 114.

Male.— Length of body, 2.5–3 mm.; uniformly black; eyes black; vertex feebly punctate; outer margin of wings smoothly curved; inner margins entire at base; posterior margin of hypandrium entire.

Female.— Length of body, 5 mm.; uniformly black; eyes and wing pads black or dark brown; ovipositor twice as long as beak.

Holotype (♀).— Helena, Montana, April 26; in United States National Museum.

Allotype, by present designation.— Bozeman, Montana, March 23; in Museum of Comparative Zoölogy.

This is apparently a rare species; I have seen ten specimens from Bozeman, Montana (March) and one specimen (♀) from Reno, Nevada, taken at 6,600 ft. It is interesting that the dates on which these specimens have been collected are much later than those for the above species. *Unicolor* resembles *brumalis* in habitus, but the male has the hypandrium entire, and the female has a much shorter ovipositor.

Boreus borealis Banks

Text-fig. 6e

Boreus borealis Banks, 1923, N. Amer. Fauna, Bur. Biol. Surv., U. S. D. A., no. 46, p. 158, pl. 9, fig. 8.

Male.— Length of body, 4 mm.; metallic brown, almost bronze; wings light yellow; eyes brown or black; outer margin of wings smoothly curved; posterior margin of hypandrium entire.

Female,— Length of body, 5 mm.; color as in male; wing pads yellow; ovipositor very nearly twice as long as the beak.

Cotypes (♂ ♀).— St. Paul Island, Bering Straits, Alaska, May 16–23, 1914 (Whitney); ♂ in Museum of Comparative Zoölogy. The location of the ♀ type is unknown to me.

In the collection of the California Academy of Sciences there are a male and female of this species, also from St. Paul Island (July–August, 1925, A. Christofferson). The wing pads of the female are about the same length as those of the other Boreus, not reaching the base of the abdomen, as described in the female type by Banks. Since the new male is unquestionably *borealis* and since the female agrees with the original description in all details except for the length of the wing pads, I believe that the female type was probably somewhat shriveled, so that the wing pads appeared relatively long. The presence of this wingless insect on St. Paul Island, three hundred miles from the coast of Alaska, is quite remarkable. It may occur in Alaska proper, and possibly migrated to the Island in the late Pleistocene, when there was land or ice connection to the continent. It is the most striking of our species of the genus; the bronze body furnishes the yellow wings with a fine background.

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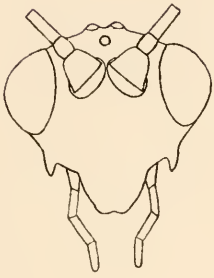
EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Brachypanorpa carolinensis* (Banks), head of ♂ cotype in Mus. Comp. Zoöl.
Fig. 2. *Brachypanorpa carolinensis* (Banks), head of ♀ allotype.
Fig. 3. *Brachypanorpa carolinensis* (Banks), ♂ genital bulb of cotype in Mus. Comp. Zoöl.
Fig. 4. *Brachypanorpa oregonensis* (MacLachlan), ♂ genital bulb.
Fig. 5. *Brachypanorpa oregonensis* (MacLachlan), head and thorax of ♀ allotype.
Fig. 6. *Panorpa lugubris* Swederus, ♂ genital bulb.
Fig. 7. *Panorpa rufa* Gray, ♂ genital bulb.
Fig. 8. *Panorpa nuptialis* Gerstaecker, ♂ genital bulb.



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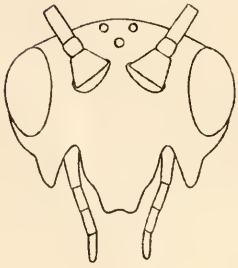

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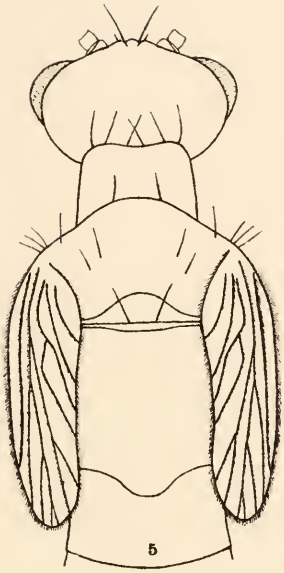

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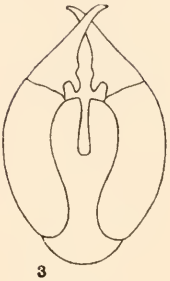

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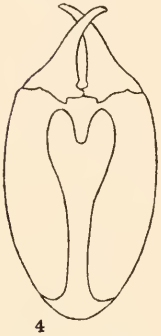

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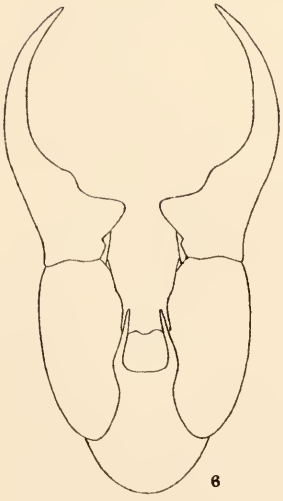

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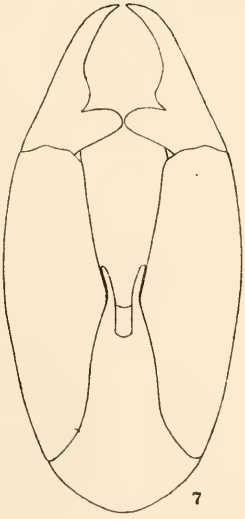

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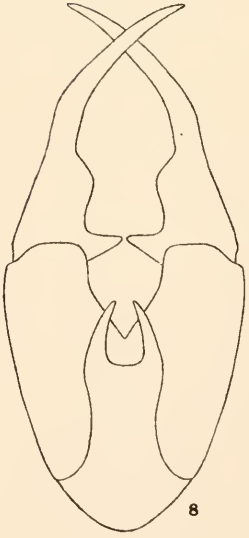

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PLATE 2

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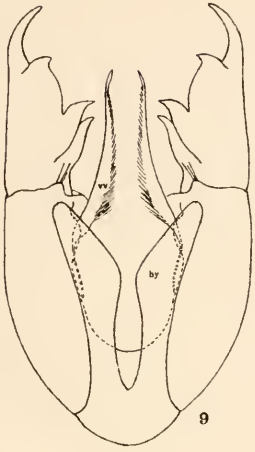
Fig. 9. *Panorpa subfurcata* Westwood, ♂ genital bulb.
Fig. 10. *Panorpa mirabilis*, n. sp., ♂ genital bulb of holotype.
Fig. 11. *Panorpa signifer* Banks, ♂ genital bulb of holotype.
Fig. 12. *Panorpa longicornis*, n. sp., ♂ genital bulb of holotype.
Fig. 13. *Panorpa carolinensis* Banks, ♂ genital bulb of cotype in Mus. Comp. Zoöl.
Fig. 14. *Panorpa modesta*, n. sp., ♂ genital bulb of holotype.
Fig. 15. *Panorpa virginica* Banks, ♂ genital bulb of holotype.
Fig. 16. *Panorpa venosa* Westwood, ♂ genital bulb.
Fig. 17. *Panorpa americana* Swederus, ♂ genital bulb.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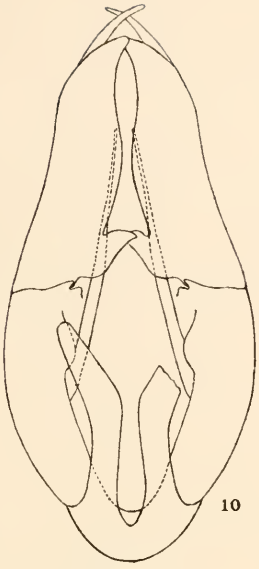
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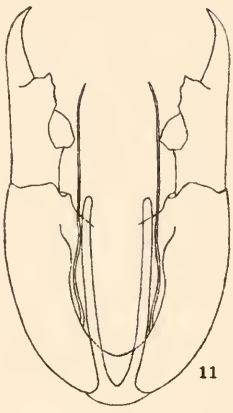
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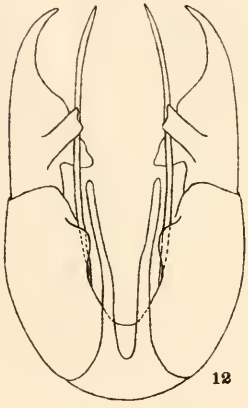
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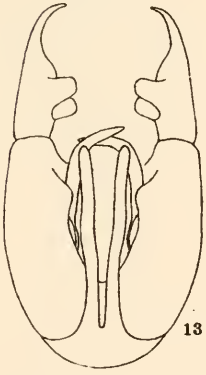
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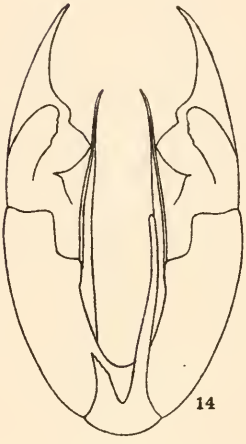
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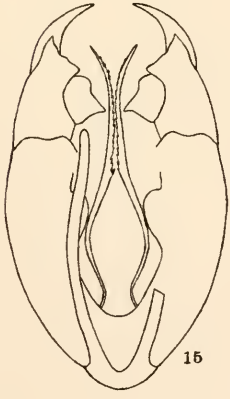
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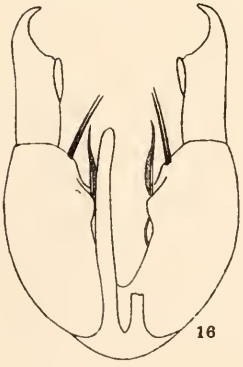
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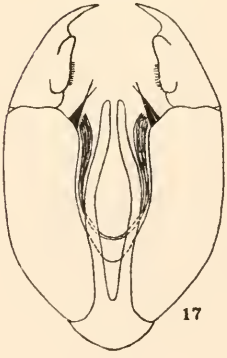
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PLATE 3

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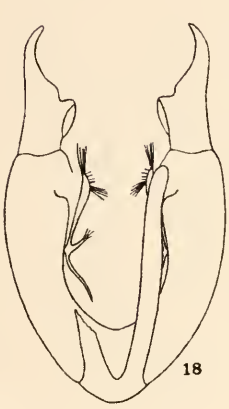
Fig. 18. *Panorpa elaborata*, n. sp., ♂ genital bulb of holotype.
Fig. 19. *Panorpa canadensis* Banks, ♂ genital bulb of holotype.
Fig. 20. *Panorpa rufescens* Rambur, ♂ genital bulb.
Dig. 21. *Panorpa robusta*, n. sp., ♂ genital bulb of holotype.
Fig. 22. *Panorpa isolata*, n. sp., ♂ genital bulb of holotype.
Fig. 23. *Panorpa neglecta*, n. sp., ♂ genital bulb of holotype.
Fig. 24. *Panorpa dubitans*, n. sp., ♂ genital bulb of holotype.
Fig. 25. *Panorpa speciosa*, n. sp., ♂ genital bulb of holotype.
Fig. 26. *Panorpa braueri*, n. sp., ♂ genital bulb of holotypes.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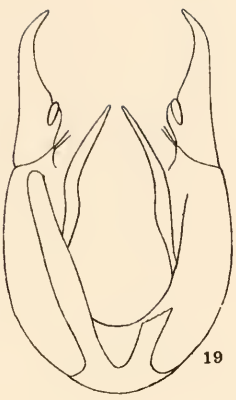
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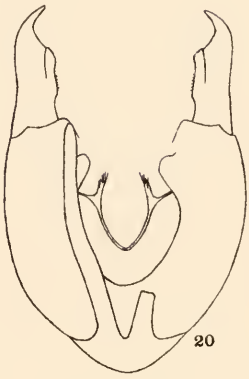
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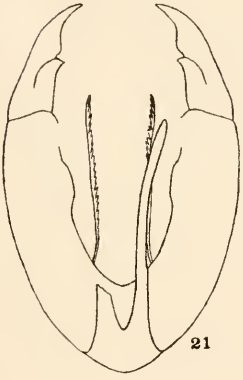
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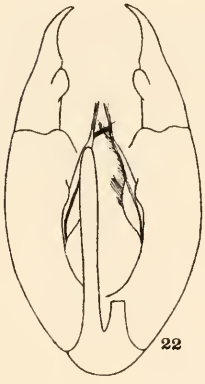
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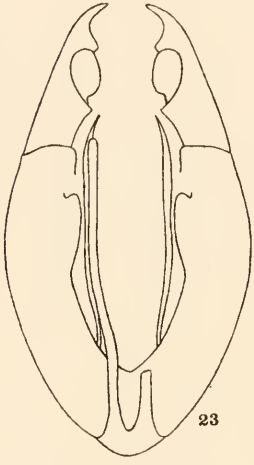
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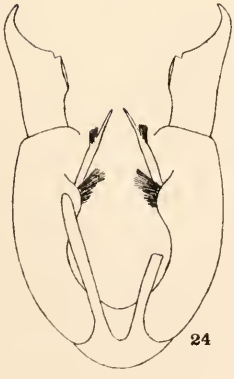
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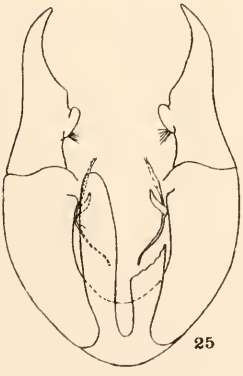
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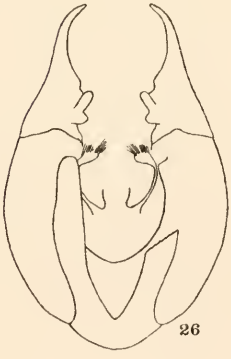
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PLATE 4

PLATE 4

Fig. 27. *Panorpa interrupta* Banks, ♂ genital bulb of holotype.
Fig. 28. *Panorpa decorata*, n. sp., ♂ genital bulb of holotype.
Fig. 29. *Panorpa anomala*, n. sp., ♂ genital bulb of holotype.
Fig. 30. *Panorpa banksi* Hine, ♂ genital bulb of holotype.
Fig. 31. *Panorpa dissimilis*, n. sp., ♂ genital bulb of holotype.
Fig. 32. *Panorpa proximata*, n. sp., ♂ genital bulb of holotype.
Fig. 33. *Panorpa gracilis*, n. sp., ♂ genital bulb of holotype.
Fig. 34. *Panorpa latipennis* Hine, ♂ genital bulb of cotype in Mus. Comp. Zoöl.
Fig. 35. *Panorpa nebulosa* Westwood, ♂ genital bulb.

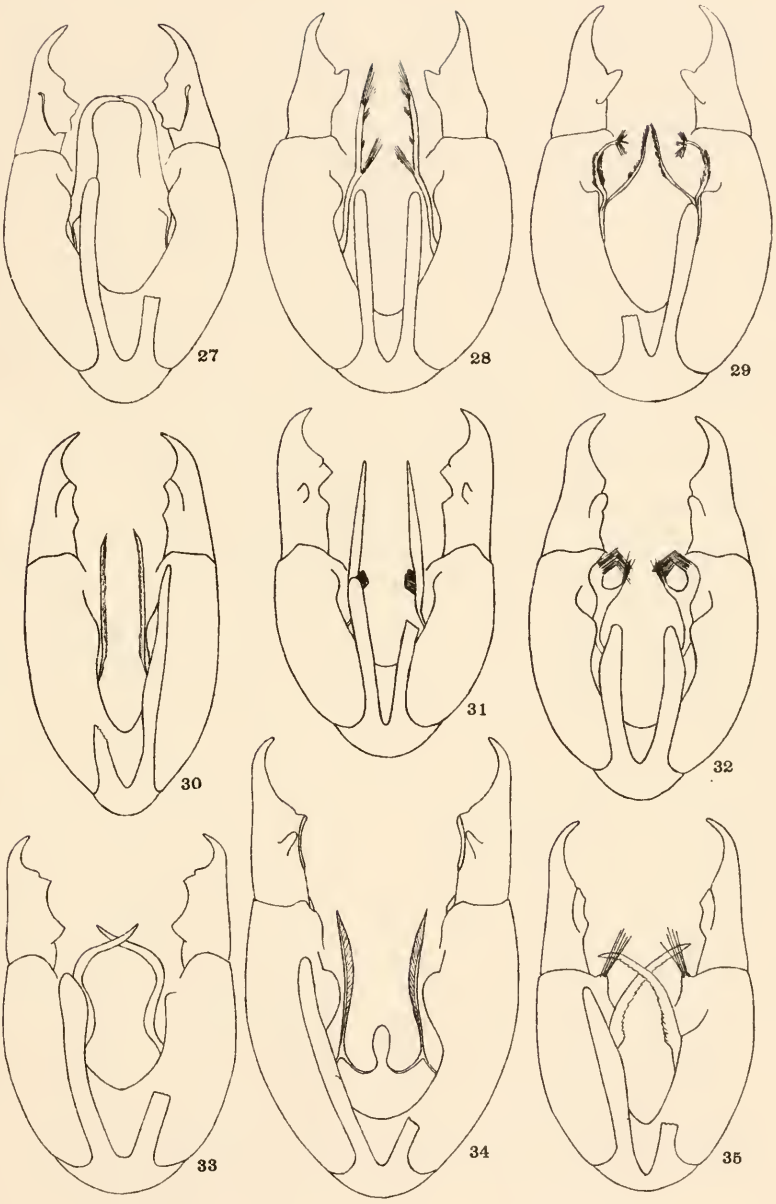
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PLATE 5

PLATE 5

Fig. 36. *Panorpa chelata*, n. sp., ♂ genital bulb of holotype.
Fig. 37. *Panorpa sigmoides*, n. sp., ♂ genital bulb of holotype.
Fig. 38. *Panorpa acuta*, n. sp., ♂ genital bulb of holotype.
Fig. 39. *Panorpa claripennis* Hine, ♂ genital bulb of holotype.
Fig. 40. *Panorpa maculosa* Hagen, ♂ genital bulb of holotype.
Fig. 41. *Panorpa submaculosa*, n. sp., ♂ genital bulb of holotype.
Fig. 42. *Panorpa nuptialis* Gerstaecker, internal skeleton of ♀.
Fig. 43. *Panorpa rufa* Gray, internal skeleton of ♀.
Fig. 44. *Panorpa lugubris* Swederus, internal skeleton of ♀.
Fig. 45. *Panorpa isolata*, n. sp., internal skeleton of ♀ allotype.
Fig. 46. *Panorpa maculosa* Hagen, internal skeleton of ♀ allotype.
Fig. 47. *Panorpa claripennis* Hine, internal skeleton of ♀ allotype.
Fig. 48. *Panorpa mirabilis*, n. sp., internal skeleton of allotype.

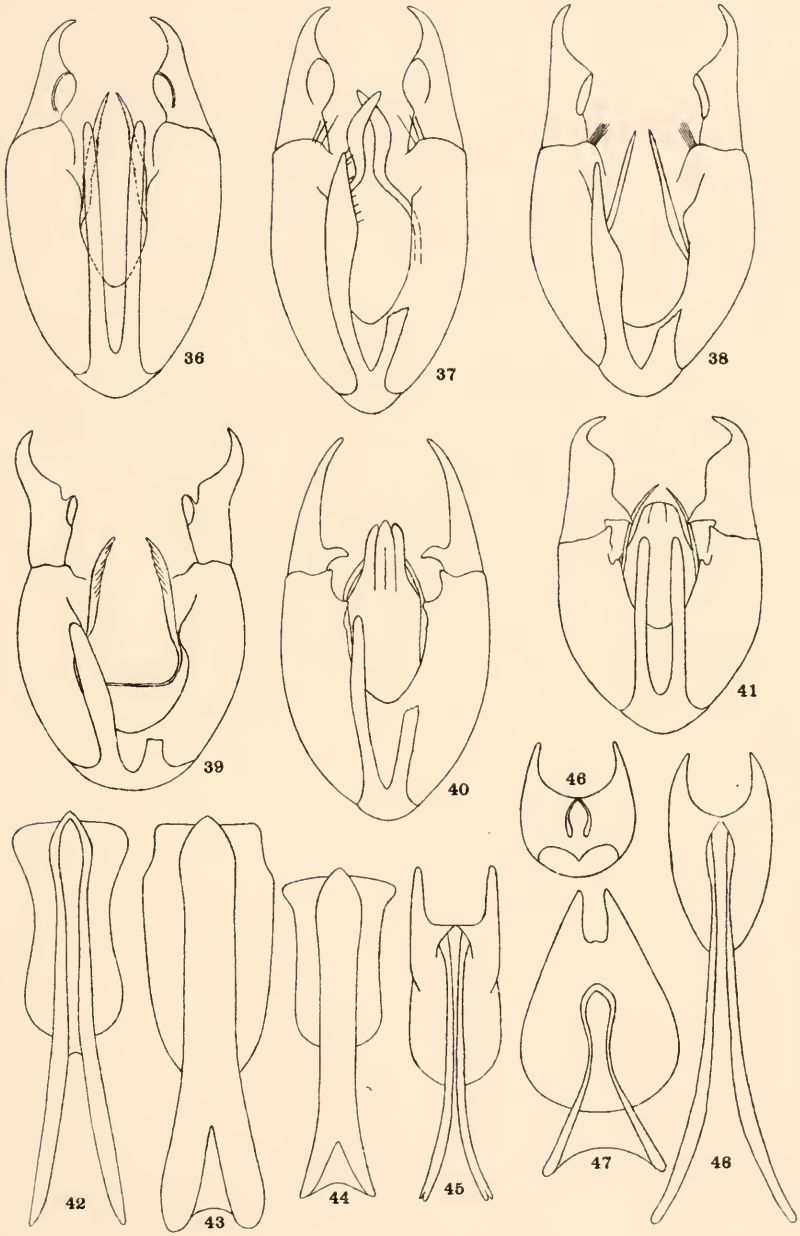
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PLATE 6

PLATE 6

Fig. 49. *Panorpa longicornis*,. n. sp., internal skeleton of ♀ allotype.
Fig. 50. *Panorpa carolinensis* Banks, internal skeleton of ♀ allotype.
Fig. 51. *Panorpa venosa* Westwood, internal skeleton of ♀ allotype.
Fig. 52. *Panorpa virginica* Banks, internal skeleton of ♀ allotype.
Fig. 53. *Panorpa interrupta* Banks, internal skeleton of ♀ allotype.
Fig. 54. *Panorpa signifer* Banks, internal skeleton of ♀ allotype.
Fig. 55. *Panorpa subfurcata* Westwood, internal skeleton of ♀.
Fig. 56. *Panorpa elaborata*, n. sp., internal skeleton of ♀ allotype.
Fig. 57. *Panorpa americana* Swederus, internal skeleton of ♀.
Fig. 58. *Panorpa rufescens* Rambur, internal skeleton of ♀.
Fig. 59. *Panorpa anomala*, n. sp., interbal skeleton of ♀ allotype.
Fig. 60. *Panorpa submaculosa*, n. sp., internal skeleton of ♀ allotype.
Fig. 61. *Panorpa canadensis* Banks, internal skeleton of ♀ allotype.
Fig. 62. *Panorpa braueri*, n. sp., internal skeleton of ♀ allotype.
Fig. 63. *Panorpa chelata*, n. sp., internal skeleton of ♀ allotype.
Fig. 64. *Panorpa latipennis* Hine, internal skeleton of ♀ cotype, Mus. Comp. Zoöl.
Fig. 65. *Panorpa nebulosa* Westwood, internal skeleton of ♀.
Fig. 66. *Panorpa sigmoides*, n. sp., internal skeleton of ♀ allotype.

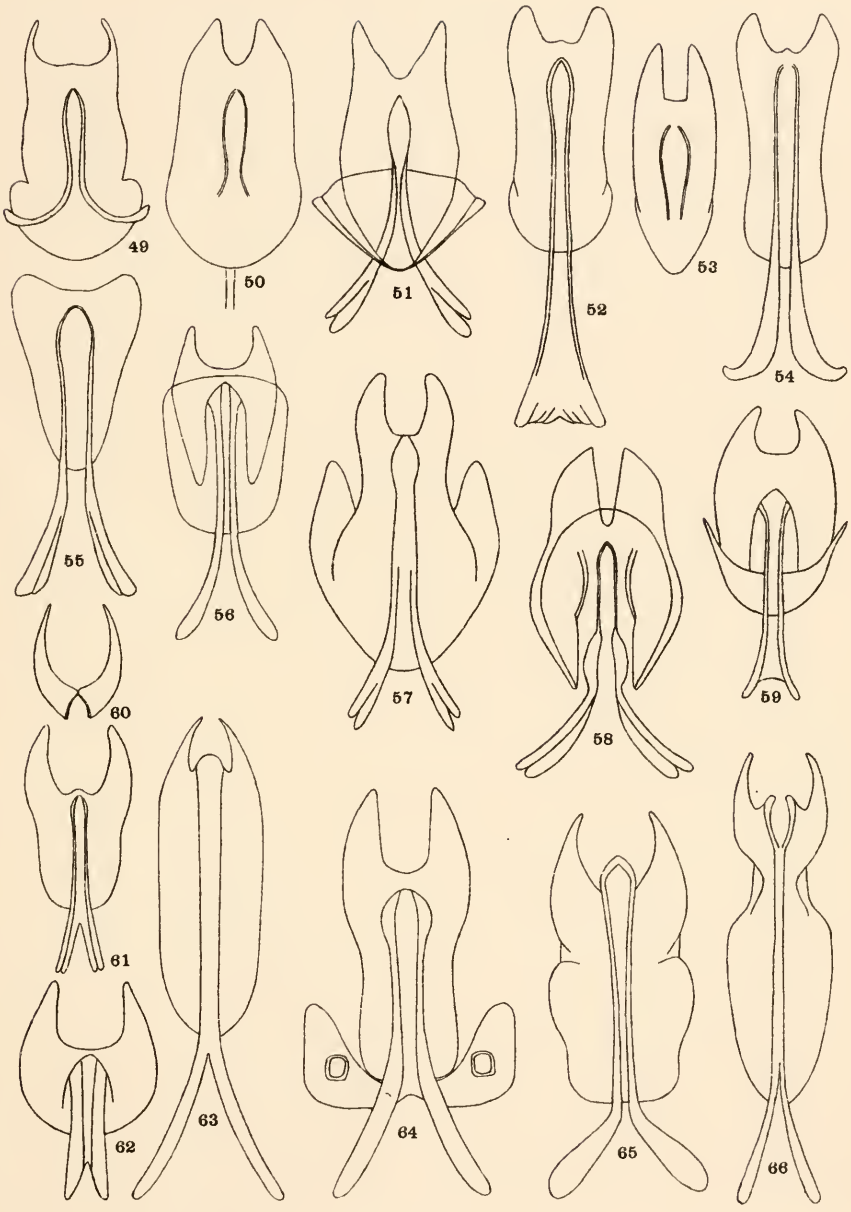
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PLATE 7

PLATE 7

Fig. 67. *Bittacus apicalis* Hagen, ♂ genitalia, holotype.
Fig. 68. *Bittacus occidentis* Walker, ♂ genitalia.
Fig. 69. *Bittacus stigmaterus* Say, ♂ genitalia.
Fig. 70. *Bittacus texanus* Banks, ♂ genitalia, holotype.
Fig. 71. *Bittacus punctiger* Westwood, ♂ genitalia.
Fig. 72. *Bittacus chlorostigma* MacLachlan, ♂ genitalia.
Fig. 73. *Bittacus strigosus* Hagen, ♂ genitalia, cotype in Mus. Comp. Zoöl.
Fig. 74. *Apterobittacus apterus* MacLachlan, ♂ genitalia.
Fig. 75. *Bittacus pilicornis* Westwood, ♂ genitalia.

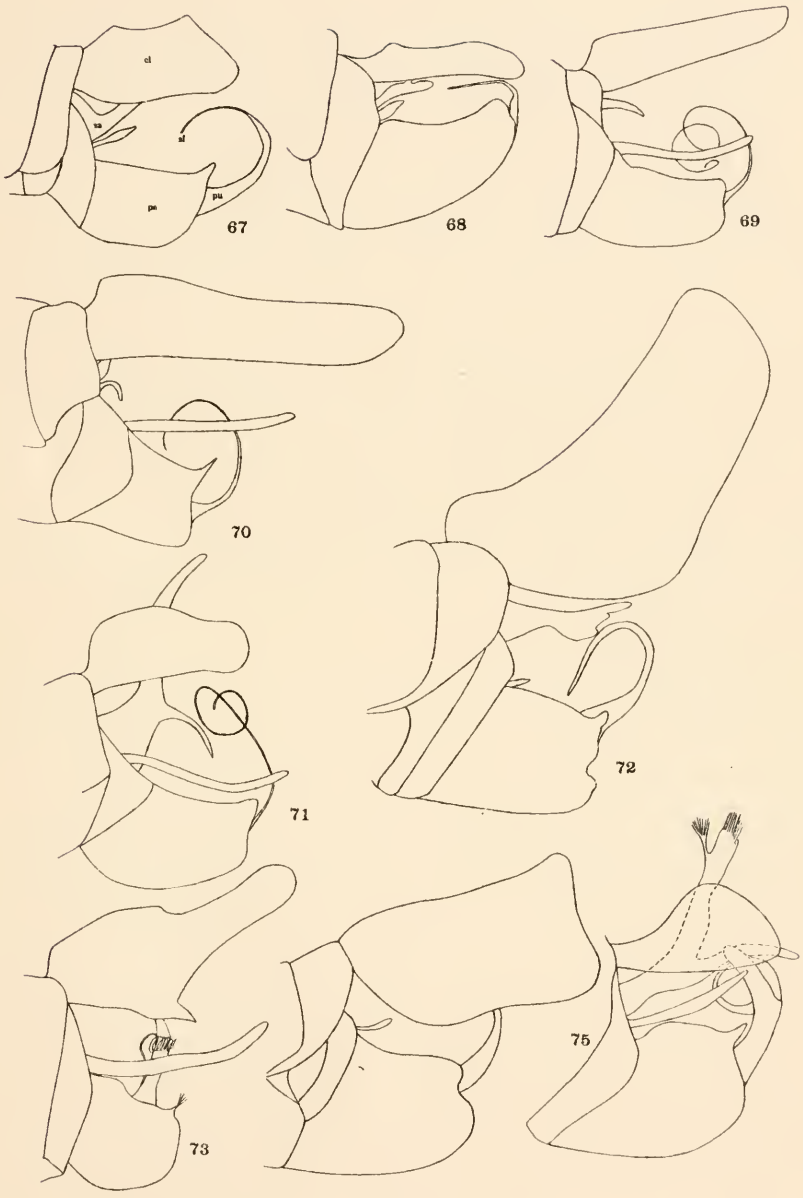
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PLATE 8

PLATE 8

Fig. 76. Fore wing of *Panorpa lugubris* Swederus.
Fig. 77. Fore wing of *Panorpa nuptialis* Gerstaecker.
Fig. 78. Fore wing of *Panorpa rufa* Gray.
Fig. 79. Fore wing of *Panorpa americana* Swederus.
Fig. 80. Fore wing of *Panorpa subfurcata* Westwood.
Fig. 81. Fore wing of *Panorpa signifer* Banks.
Fig. 82. Fore wing of *Panorpa elaborata*, n. sp.
Fig. 83. Fore wing of *Panorpa rufescens* Rambur.
Fig. 84. Fore wing of *Panorpa canadensis* Banks.
Fig. 85. Fore wing of *Panorpis claripennis* Hine.
Fig. 86. Fore wing of *Panorpa nebulosa* Westwood.
Fig. 87. Fore wing of *Bittacus apicalis* Hagen.
Fig. 88. Fore wing of *Bittacus chlorostigma* MacLachlan.
Fig. 89. Fore wing of *Bitticus strigosus* Hagen.
Fig. 90. *Apterobittacus apterus* MacLachlan.

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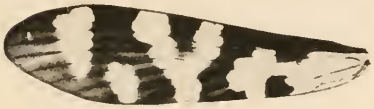

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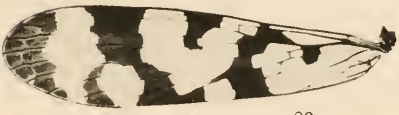

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TWO FRESHWATER OSTRACODS FROM NORTH AMERICA

BY CHARLES H. BLAKE
Massachusetts Institute of Technology

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No. 7.— *Two Freshwater Ostracods from North America*

By Charles H. Blake

Two species of freshwater Ostracoda in the collection of the Museum of Comparative Zoölogy were entrusted to me for examination by Dr. Hubert Lyman Clark. The species proved to be of considerable interest. One, a *Cyprinotus*, is new and the other, a *Cypriconcha*, has never been adequately described. I have given rather detailed descriptions of these forms so that it may be possible to establish them in the midst of the rather numerous, insufficiently known forms from the fresh waters of North America.

I wish in this place to tender my best thanks to Dr. Clark for his kindness in permitting me to examine this material.

CYPRIDAE

Cyprinotus and *Cypriconcha* both belong to the subfamily Cyprinae as taken by G. W. Müller and by G. O. Sars. It is, however, a matter of great uncertainty just what limits should be assigned to the subfamilies of Cypridae.

Cyprinotus Brady 1885

Skogsberg (1917, pp. 9–21) has given the most accurate and complete account we have of a species (*C. gregarius*) of this genus. His description of the number and position of the setae on the various appendages is particularly helpful and in the following description it may be assumed that, unless otherwise stated, the number, position, and general form of the bristles is as in his description.

Cyprinotus sulphureus spec. nov.

(Figs. 1–12)

Female.— The shell is quite devoid of setae except at the margins. Seen laterally, it is elliptical except for the ventral flattening, the ends evenly rounded and the anterior but slightly more curved than the posterior. Seen dorsally, the two ends are virtually identical in form. The left valve barely exceeds the right in size (1.8 per cent longer) but overlaps it distinctly, due to the infolding of the anterior

and posterior margins of the right valve. The anteroventral tubercles of the right valve number about 25 and the posteroventral about 26 or 27. The width of the inner lamella at the anterior end of the right valve equals $7\frac{1}{2}$ per cent of the length of the valve.

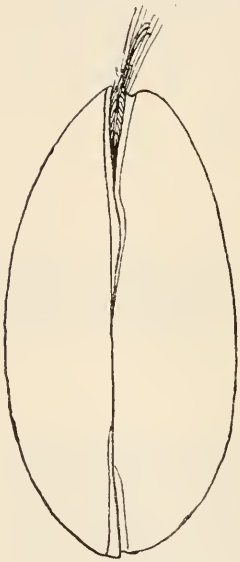

Fig. 1. Dorsal view. x 50.

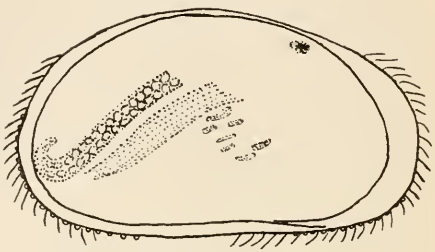

Fig. 2. — Right lateral view. x 50.

Fig. 3.— Second antenna.

The left valve is 1.16 mm. long and 0.75 mm. high. The corresponding figures for the right valve are 1.14 mm. and 0.73 mm. Referred to the length of the left valve as unity, the height of that valve attains 65 per cent. The breadth of the whole shell is 49 per cent.

The appendages are of the general form characteristic of the genus.

The second antenna bears on the posterior margin of the first endopod segment some eight groups of minute setae. The natatory bristles of this limb do not quite reach the tips of the terminal claws (Fig. 3).

The conical bristle of the mandibular palp is rather longer than in *C. gregarius* and ends in a long, thin point (Fig. 11).

The maxilla is similar to that of *C. gregarius* but the first process

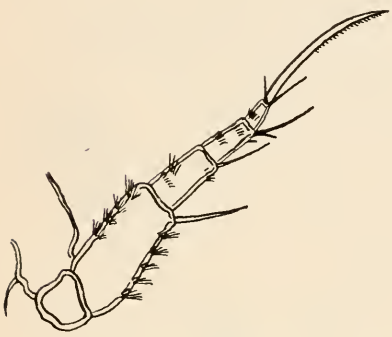

Fig. 4.— Sixth limb.

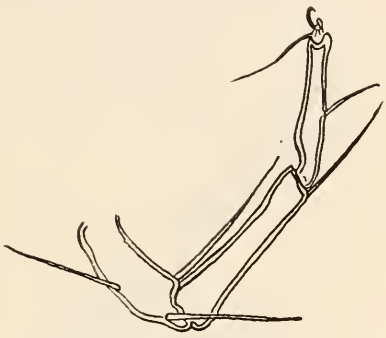

Fig. 5.— Seventh limb.

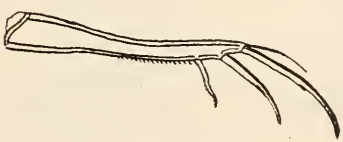

Fig. 6.— Furca.

bears about sixteen spines instead of thirteen. The second process bears nine as in Skogsberg's species. As to the third process, it is not quite certain whether the spines number ten or eleven. The chief spines of this process are strongly denticulate (Fig. 12).

The sixth limb (Skogsberg) bears on the posterior margin of the first endopod segment four fascicles of fine setae and on the anterior margin five such fascicles. The next segment has a medial posterior fascicle and just proximal to it a row of very short setae. The anterior side of the same segment has a distal fascicle of setae. The third segment bears two posterior rows of fine setae. The last has one pos-

terior row. The claw of this limb is almost exactly equal in length to the three segments preceding it.

The furcal rami are slightly sinuate. Referred to the length of the front margin as unity, the depth of the ramus at the middle of this margin is eight per cent, at the base 17 per cent. The length of the

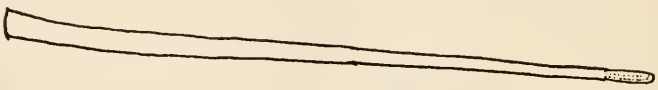

Fig. 7.— Sensilla of terminal segment of first antenna. x 800.

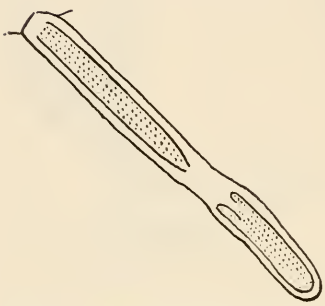

Fig. 8.— Sensilla of first endopod segment of second antenna. x 800.

Fig. 9.— Sensilla of second endopod segment of second antenna. x 800.

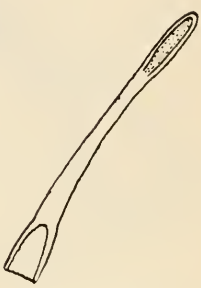

Fig. 10.— Sensilla of third endopod segment of second antenna. x 800.

Fig. 11.— Conical bristle of mandibular palp. x 800.

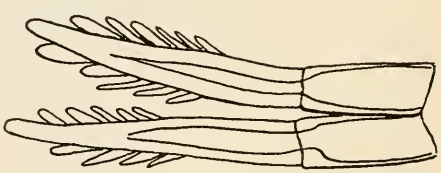

Fig. 12.— Chief spines of third process of maxilla. x 800.

front claw is 59 per cent. The claws and setae have the following relative lengths, taking the front claw as 100: front seta 45; hind claw 69; hind seta 60.

Sensillae. In Figures 7 to 10 I have figured four sensory bristles occurring on the antennae. The seta shown in Figure 9 may not be sensory. All are shown at the same magnification (800 diameters). Figure 7 shows the dorsal setae of the end segment of the first antenna. No division of the proximal part into manubrium (base) and middle piece could be observed. The receptorium (tip) includes $7\frac{1}{2}$ per cent

of the length of the seta. The posterior sensilla of the first endopod segment of the second antenna (Fig. 8) shows a clear division into three portions as named above. The manubrium is 55 per cent of the length of the seta, the middle piece 11 per cent, the receptorium 34 per cent. The posterodistal bristle of the penultimate segment of the second antenna (Fig. 9) is a doubly curved, naked seta not divisible into regions. The sensory, posterior seta of the end segment of the second antenna (Fig. 10) has a short basal part (19 per cent) joined to the adjacent seta, a rather long middle piece (55½ per cent) and a shorter receptorium (25½ per cent). I have described these structures in some detail since they appear to be rather constant in form and, moreoever, they show rather evident differences in proportion when compared with the same sensillae in *C. gregarius*. Further, they show some interesting size relations when compared with the much larger species to be described below.

Male.— Unknown. The species is probably exclusively parthenogenetic.

Occurrence.— Sulphur Spring (Iron County?), Utah. Numerous females were taken here by Dr. H. C. Yarrow in October. 1872.

Diagnostic features.— This species may be distinguished from its congeners by: (1) the proportions of the shell and the number of tubercles on the right valve; (2) the proportions and armature of the furca.

Remarks.— Attention should be called to the use of certain ratios in the foregoing description. It will be noticed that all of these are expressed as decimals to render comparison between species easier than when such ratios are expressed as common fractions.

In describing the furca I have used "front" and "hind" to avoid the morphological connotations of "anterior" and "posterior." The width of the base of the furcal ramus is measured normal to the axis at the base of the front margin. Curves are disregarded throughout.

Certain characters have rarely or never been alluded to in descriptions and are particularly applicable to the description of these parthenogenetic forms. The most important of these is the size, shape, and position of the portion of the ovary and oviduct between the lamellae of the valve. It is quite certain that the details of its structure vary from species to species, but equally, they are quite constant within the species. In Figure 2 I have shown this organ and also the interlamellar portion of the shell gland. Further, the width and form of the inner lamella and the number of tubercles on the valve are good characters in *Cyprinotus*.

C. sulphureus runs out in Müller's key (1912, p. 162) to *C. congener*, an East African species. *C. incongruens* also belongs here, being inaccurately placed in the key, as shown by the descriptions, including Müller's on page 165. In addition, *C. zugmayeri* (Baluchistan) and *C. vandouwei* (China) also fall here. The two latter species are set apart by having the pectination of the furca much reduced in extent and divided into three combs. From *C. congener*, the present species is at once distinguished by the greater proportionate height of the shell, 65 per cent as against 50 per cent. The furca is more curved than in *congener*. *C. incongruens* lacks the pectination of the hind margin of the furca.

The following species of *Cyprinotus* have been reported from North America: *pellucidus* (Sharpe), *incongruens* (Ramdohr), *dentatus* (Sharpe), *americanus* Cushman, *crena* (Turner), *burlingtonensis* (Turner), and *californicus* Baker. Of these the last two are quite insufficiently described. Probably at least two species have been confused under the name *incongruens*. The following key should distinguish the better described species.

1. Left valve overlapping right 2
   Right valve overlapping left . . . . . *pellucidus*
2. Front bristle of furca more than one-third the length of front claw 3
   Front bristle less than one-third as long as front claw 4
3. Natatory setae of second antenna overreach the terminal claws. *incongruens*
   These setae do not reach the tips of the terminal claws . . . . . *sulphureus*
4. Furca strongly bowed . . . . . *crena*
   Furca nearly straight 5
5. Left valve rather pointed anteriorly . . . . . *dentatus*
   Left valve very broadly rounded anteriorly . . . . . *americanus*

Sharpe says of *americanus* that the right valve is the larger. This is not clear from the original description.

Cyprinotus sulphureus may also be distinguished from *incongruens* by the somewhat different form of the shell.

I do not feel able to maintain the genus *Heterocypris* as advocated by Sars. The alleged differences seem too tenuous to be of generic rank.

Cypriconcha G. O. Sars, 1926

This genus has been recently proposed for the large *Cypris barbata* S. A. Forbes. Sars (1926, p. 4) knew but the type species. A careful comparison with a second species, which I am able to add to the genus, enables me to list a number of characters which distinguish it from one or more of the several members of the group Eucyprides to which it evidently belongs.

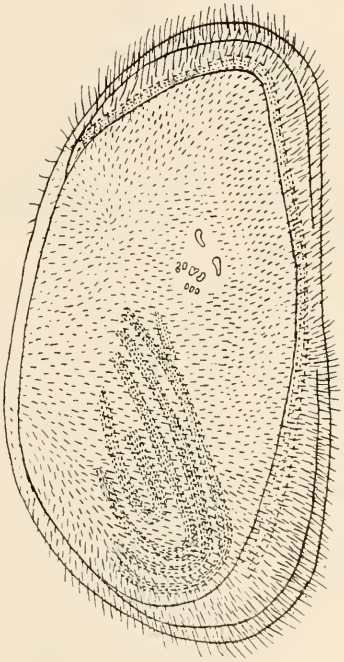

Fig. 13.— Right lateral view of male. x 21.

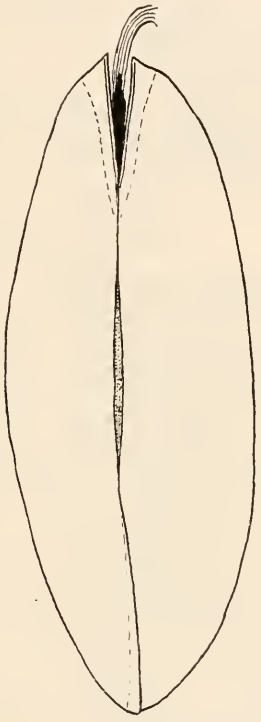

Fig. 14.— Dorsal view of male. x 21.

The shell is rather large (3.4–4.2 mm. long), compressed, and lower in front than behind. The inner lamella is broad, with the inner margin thickened.

The natatory setae of the second antenna extend to the middle of the claws of the penultimate segment. This segment in the male is armed with one short and three long claws.

The vibratory plate of the mandible bears five terminal setae and

one shorter, anterior seta. The end segment of the palp is somewhat contracted distally. No conical bristle is present.

The end segment of the maxillary palp is about twice as long as wide and cylindrical. The chief spines of the third maxillary process are smooth.

The penultimate segment of the sixth limb lacks the medioanterior seta.

The penultimate segment of the seventh limb is not prolonged distally into a thumb. The last segment is very minute and without a fingerlike process.

The furca, at least in the male, is quite strongly bowed. The pectination of the ramus is divided into combs.

The testes and their ducts do not extend into the anterior part of the valves.

Cypriconcha macra, nom. nov.

(Figs. 13–26.)

Cypris grandis Chambers (1877, p. 151) non *C. g.* Reuss 1852.

Male.— The valves are nearly equal, the left valve very slightly overlapping the right at each end. Viewed laterally, the greatest height is about two-thirds the way back. The greatest height of the right valve is 48 per cent of the length. The inner lamella is broadest at the posterior end of the ventral margin. Its inner margin shows a marked anteroventral angulation. This margin, anteriorly and ventrally, is bounded by a rather broad, thickened band. The inner lamella at the middle of the anterior margin attains a width equaling $7\frac{1}{2}$ per cent of the length of the valve. The breadth of the closed shell is 37 per cent of its length. Total length of shell is 3.9–4.15 mm. The valves are well calcified but fragile; they are covered with abundant, very transparent hairs, longest and most numerous at the ends of the valves.

The first antennae are almost as in *C. barbata*. The proportionate lengths of the last five segments referred to the first of these are 100: 80: 50: 65: 43.

The second antenna has the first two segments of the endopod relatively stouter than in *C. barbata*. Three of the anterodistal setae of the second endopod segment are long claws and one a short claw. The tip of the third endopod segment has the usual setae including one claw. This claw is sharply bent at the tip and the pectination of its distal half consists of remarkably long, strong teeth.

The mandible and maxilla are scarcely to be distinguished from

those of the type species. The mandible has six teeth and medial to them some bristles including two bearded bristles. The exterior tooth is two-pointed, the others are indistinctly three-pointed as shown in Figure 24 for the fifth tooth. The medial seta of the anterior group on the penultimate palpal segment is distinctly unguiform. The vibratory plate of the maxilla bears twenty-six setae.

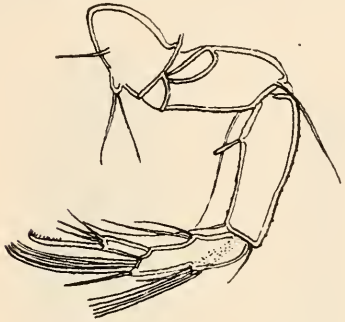

Fig. 15. Second antenna of male.

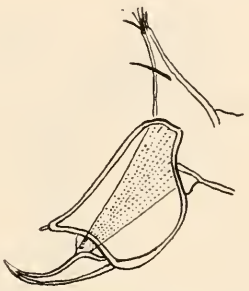

Fig. 16.— Right fifth limb of male.

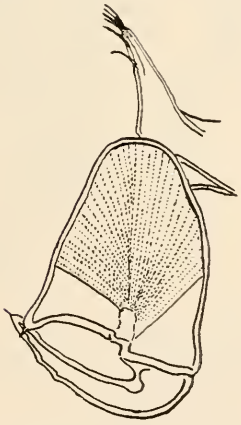

Fig. 17.— Left fifth limb of male.

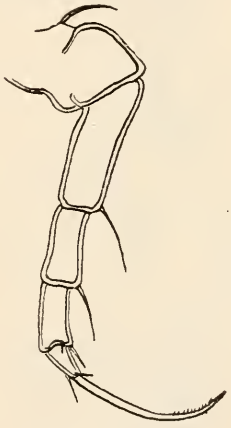

Fig. 18.— Sixth limb of male.

The members of the fifth pair of limbs are strongly unlike, the left (Fig. 17) being much stouter than the right (Fig. 16). The sixth and seventh limbs are scarcely to be distinguished from those of *C. barbata* except for the slightly greater relative length of most of the setae of the seventh limb.

The furca is long and slender, the width at the middle being $6\frac{1}{2}$ per cent of the length of the front margin of the ramus. The front claw is 41 per cent of the length of the front margin, disregarding curves. The front seta is rather short, though its length is difficult to determine owing to the condition of the material.

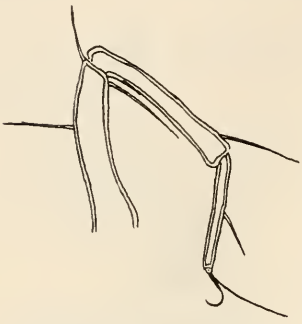

Fig. 19. Seventh limb of male.

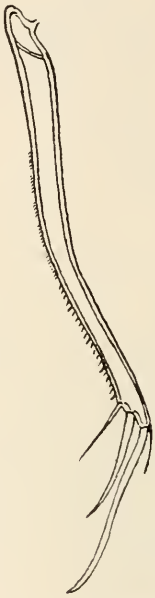

Fig. 20.— Furca of male, claws from another specimen.

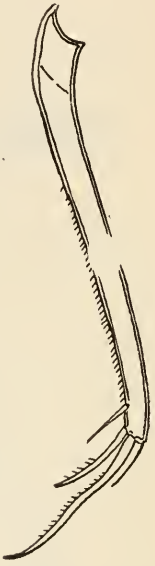

Fig. 21.— Furca of female.

Fig. 22.— Penis.

The penis is subtriangular and rather acute terminally. The ejaculatory tube shows between 65 and 70 spines in profile. They are difficult to count even after removing some of the dense muscular sheath. It is

probable that the spines are arranged in a close, even spiral and not in the whorls shown in Figure 23.

Female.— A female specimen was not dissected. The shell resembles that of the male very closely. It is but little longer (about 4.2 mm.). The position of the ovaries and shell gland could not be determined. The furca is nearly straight and of about the same proportion as in the male.

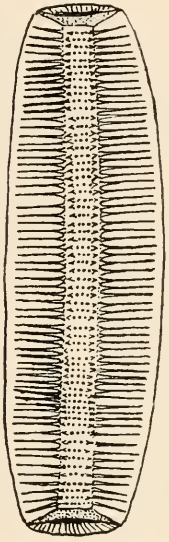

Fig. 23.— Ductus ejaculatorius.

Fig. 24.— Fifth tooth of mandible of male. x 800.

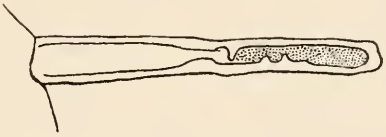

Fig. 25.— Sensilla of first endopod segment of second antenna, male. x 800

Fig. 26.— Sensilla of second endopod segment of second antenna, male. x 800.

Sensillae.— In Figures 25 and 26 I have shown the sensillae corresponding to those shown for *Cyprinotus sulphureus* in Figures 8 and 9 and at the same magnification. As will be seen, they are but little larger (1.1 times as long), though the present species attains nearly four times the length of *C. sulphureus*. The manubrium of the posterior sensilla of the first endopod segment of the second antenna is 38 per cent of the organ, the middle piece $18\frac{1}{2}$ per cent, the receptorium $43\frac{1}{2}$ per cent. The sensilla of the tip of the second antenna is $2\frac{3}{4}$ times as long as the corresponding one in *C. sulphureus* but only $1\frac{1}{2}$ times as thick. The parts occupy $23\frac{1}{2}$, 60, and $16\frac{1}{2}$ per cent of the length. The receptorium is slightly clavate.

Occurrence.— The specimens bore an ancient and illegible label. From ulterior evidence I think it not impossible that these are some or all of Chamber's original lot collected in Colorado. One male lacked both fifth limbs and most of the specimens lacked the front seta of the furca as in his description, though its socket was present in all cases.

Diagnostic features.— The two species of this genus may be distinguished by the following couplet.

1. Inner shell margin evenly rounded anteriorly ..... *barbata*
   Inner shell margin angulated anteroventrally ..... *macra*

The copulatory appendages of the male are very strikingly different in detail in the two species. The division of the pectination of the hind margin of the furca is very obscure in *macra* but well defined in *barbata*.

Remarks.— It was not possible to obtain accurate counts of the bristles of the mandible and maxilla as these parts were especially heavily obscured by a growth of sessile commensal Protozoa. These animals were more or less prevalent on all the appendages.

It is interesting to note the forms which are recorded as equaling or exceeding these species of *Cypriconcha* in size. From fresh water we know eight from Africa, one from the West Indies, and one from Australia. Of these the largest is *Megalocypris princeps* of South Africa with a length of 7.70 mm. It is, therefore, the largest species of the suborder Podocopa. This species is in turn exceeded by seven marine Myodocopa, of which the largest is *Gigantocypris agassizii*, 21 mm. long. A considerable number of fossil forms are known with lengths in excess of four millimeters.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE

VOL. LXXII, No. 8

A REVISION OF THE PLEISTOCENE SPECIES OF TERRAPENE OF FLORIDA

BY THOMAS BARBOUR AND H. C. STETSON

WITH THREE PLATES

CAMBRIDGE, MASS., U. S. A.:

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DECEMBER, 1931

No. 8.— *A Revision of the Pleistocene Species of Terrapene of Florida*

By Thomas Barbour and H. C. Stetson

Four species of Terrapene are currently recognized from the Pleistocene of Florida, all found within short distances of each other in east coast localities. The senior author has long held the opinion that these Pleistocene forms should probably be reduced to one species, in view of great variation exhibited by the existing *T. major* in the size and proportions of the carapace.

We wish to thank Dr. Leonhard Stejneger for very kindly loaning specimens of *T. major* to supplement our own series.

In 1929 new material from the Pleistocene at Melbourne was acquired by the Museum of Comparative Zoölogy from Mr. C. P. Singleton. Five complete carapaces were received, as well as many fragmentary ones. In this large series, individuals were found combining the diagnostic characteristics of the described species, thereby bridging the gap between them. A series of specimens of *T. major* was selected with the object of obtaining as great a variation as possible in the size and proportions of the carapace, and in the other chief diagnostic characteristics of the fossil species. It was found that the Pleistocene species could be successfully duplicated within the existing *T. major.*

T. canaliculata Hay (1907–08) was described from fragments found near Savannah, Georgia, in 1907. Since then it has been redescribed by Gilmore (1927) from several good specimens found at Melbourne and Vero, Florida. Its main characteristics are: carapace suboval in outline, being wide and broadly rounded behind; low median keel interrupted at the sulci; vertebral scutes flattened; posterior peripherals strongly flaring; keel over bridges; first vertebral scute urn-shaped, with posterior portion wider than anterior.

T. formosa Hay (1916) was found at Ocala, Florida. The type specimen is the hinder two thirds of the carapace. The shell is high and broad with a dorsal keel. Hinder border of carapace flares outwards until lower surface is horizontal. There is a low lateral keel. The estimated length is 155 mm.

T. antipex Hay (1916), founded on fragments of carapace and plastron, has already been described by Gilmore (1927, p. 4) as a synonym of *T. canaliculata* Hay (1907).

T. innoxia Hay (1916) was found at Vero, Florida. The type is a complete carapace, which is thin and narrow, with the greatest height

in the middle of length. The nuchal bone is not excavated and the hinder peripherals have practically no flare. The length is 125 mm.

The type of *T. singletoni* Gilmore (1927) was found two miles west of Melbourne, Florida and consists of a nearly complete carapace. The shell is long and narrow and highest in the center; the nuchal border is broadly and shallowly excavated. The borders of the carapace have a very slight flare and there is no lateral keel over the bridge. A low median keel traverses the first, second and third vertebral scutes, but is poorly developed on four and five. The estimated length is 200 mm. Gilmore says (1927, p. 3) "from *T. canaliculata*, which it most nearly resembles, it is distinguished by its smaller size, thinner shell, absence of lateral keel above the bridges, relatively narrower carapace, with greatest width at the middle, first vertebral widest at the anterior end, and with thickened posterior peripherals that are but little flared upwards."

From the foregoing descriptions it will be seen that the most important diagnostic characteristics for all the species are: the shape and proportions of the shell, dorsal and lateral view; the presence or absence of lateral keels; the shape of the first vertebral scute; and the amount of flare of the posterior peripherals.

Plate **1**, fig. 1 has the shape and general proportions of *T. singletoni* as figured by Gilmore (1927, Plate **1**), although somewhat larger, being 262 mm. in length measured in a straight line at the center. It is broadest in the middle, as opposed to *T. canaliculata*, which is wide and broadly rounded behind, and it has relatively narrow proportions. The first vertebral scute is wide forward, and the medial keel is not broken by the sulci as in *T. canaliculata*. On the other hand, like *T. canaliculata*, the posterior peripherals have a moderate flare, there is a low keel above the bridges, and the nuchal border is not "broadly and shallowly excavated." Plate **1**, fig. 2 is a closer approach to *T. canaliculata* as figured by Gilmore (1927, Plates **2** and **3**) but still retains a certain mixture of characteristics. The general shape is that of *T. singletoni*, as it is not "wide and broadly rounded behind." On the other hand, the posterior peripherals have a strong outward flare and in reality turn upwards. The lateral keels are well developed and show the gutter-like grooves above it. This individual has an additional pair of costals.

Plate **1**, fig. 4 is also a typical *T. canaliculata* with strongly flaring peripherals and well marked lateral keels. Its peculiarities are an excavated nuchal border, deeply incised sulci, the flaring first vertebral scute with a very strongly developed dorsal keel.

A close study of Plate 1 will set forth the variation of these five individuals more adequately than descriptions can do. Dr. C. W. Gilmore in a letter to the senior author says of these specimens, "after comparing the photos with the types of *Terrapene canaliculata* and *T. singletoni* and other specimens in our collections, I agree with your suggestion that your specimens bridge the gap between the two species. Certainly the characters selected by me largely disappear in the light of your specimens. Is it not possible that the smaller *T. singletoni* might be the female of *T. canaliculata*?" Consequently *T. singletoni* becomes a synonym of *T. canaliculata*, which has priority. The description of *T. formosa* answers in every way to Plate 1, fig. 5. However, after observing the variations in *T. major*, to be described below, this species as well as *T. innoxia*, can only be regarded as the young of *T. canaliculata*. Consequently they likewise should be synonyms.

With the diagnostic characteristics of the four fossil species in mind, a survey of the existing *T. major* shows that none of them are constant, but that any one may be modified or obliterated in a given individual. They cannot, therefore, have specific value. The specimens of *T. major* figured here were chosen to show as wide a variation as possible.

Plate 2, fig. 1 is an individual in which the greatest width is at mid-length. Neither the posterior nor anterior peripherals have much flare, nor are there any lateral keels. As in the fossil forms the greatest height is about mid-length and the slope forward and back is fairly even. It is exactly the same as the *T. canaliculata* figured by Gilmore (1927, Plate 4). This should be contrasted with the more usual profile of *T. major*, Plate 2, fig. 2, in which the greatest height is posterior to mid-length, and the slope very unequal. Returning to fig. 1, the first vertebral scute is urn-shaped and widest in front. Comparison with the other specimens of *T. major* will show that this is also a very variable feature. The close correspondence to *T. singletoni* should be noted. The latter, however, is narrower forward, and Plate 3, fig. 2 shows an individual of *T. major* which is perhaps more like it in general outline. In this latter specimen the greatest width is also at mid-body. However, the anterior peripherals have a slight flare and there are poorly developed lateral keels. The dorsal keel is altogether lacking and the greatest height is past the mid-body point and descends steeply to the rear. The first vertebral scute is urn-shaped and of equal width front and back.

A contrast to the two mentioned above is shown by the individual figured in Plate 2, figs. 2 and 3. Here the carapace is broadest behind and narrow in front, the anterior and posterior peripherals flare so

strongly that they recurve, and there are well developed lateral keels with gutters over them. The first vertebral scute is broadest behind. As mentioned before the greatest height is post mid-length.

A modification of the type shown in Plate 2, fig. 1 is the specimen shown in Plate 3, fig. 1. There is no flare to the peripherals and the shell is symmetrical, being about as broad in front as behind, with the greatest width in the middle. There are no lateral keels and the dorsal keel is low. The carapace is very high and slopes steeply either way from the mid-point.

Plate 3, fig. 3 shows still another variation, the carapace is high and narrow with a moderate flare to the peripherals, with poorly marked lateral keels, but a well developed dorsal keel. The first vertebral scute is unusual in being straight sided and widest in front.

Plate 3, fig. 4 shows a heavy, robust carapace, broadly rounded behind and with a strong flare to the peripherals. The width closely approaches the length. Compare this individual with figure 1 on the same plate and again with figures 2 and 3, Plate 2, and we can get perhaps the greatest contrast. There is more variation between these individuals than is found between any of the fossil forms.

As *T. major* demonstrates so clearly, the carapace of a box turtle is an exceedingly variable thing, and the many changes of shape and proportion which it may assume cannot be regarded as of specific value. Were it not for the living form, the case would be more obscure, but with this series before us it is evident that the differences between *T. canaliculata* and the other Pleistocene forms are differences of degree. Consequently they can be regarded only as variations of a single species.

An extreme instance of this is furnished by *Kinixys belliana*, a box turtle from East Africa. Some members of this species have a high, rounded shell, in others it is completely flattened. This latter form inhabits rocky thorn-bush country, while the former lives in open forests. In each case the shape of the carapace is probably an environmental response, as the flattened form has acquired the habit of creeping under rocks for protection. If these carapaces were found as fossils they would undoubtedly be considered distinct species because of their diverse shape, and for the additional reason that they inhabit two different regions. With incomplete anatomical evidence, as is often the case with fossils, the name may have little zoölogical significance, but it is still useful in calling attention to a variation caused by a marked difference in habitat and environment, or by a considerable lapse of time. The Pleistocene Terrapene, however, do not fit into this category.

We have seen how the recent and fossil specimens illustrated here bridge the gaps between *T. singletoni* and *T. canaliculata*. The variations represented by *T. formosa* and *T. innoxia* can best be appraised by comparison with the series of *T. major* but we consider these also synonyms of *T. canaliculata*. In every case the characteristics selected as specific can be duplicated in the living form. We have seen that some carapaces are high and narrow, others rounded and broad, some are narrow in front and broad behind, others a perfect oval. The slope in profile, front and rear, may be even or abrupt, the greater height may be at mid-length or posterior to it, and the same applies to the width. The first vertebral scute may be narrow in front, or it may be wide, and the dorsal and lateral keels may be strongly or poorly developed. The posterior peripherals may have a decided flare or none at all.

T. major is generally considered to be the direct descendant of the Pleistocene form. It differs in no way, except in size, as far as the carapace goes. It inhabits exactly the same area geographically, and its environment probably has been little changed since the late Pleistocene. Sufficient evidence has been presented to show how uncertain a feature the carapace of a box turtle can be. Variations of shape and proportions, in themselves alone, are not sufficient to warrant the erection of new species.

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EXPLANATION OF PLATES

PLATE 1

PLATE 1

Fig. 1. *Terrapene canaliculata* Hay. Melbourne, Florida. M.C.Z. 1024. This specimen successfully combines the characteristics of *T. singletoni* and *T. canaliculata*. Length 262 mm. Width 167 mm.

Fig. 2. *Terrapene canaliculata* Hay. Melbourne, Florida. M.C.Z. 1025. This individual shows a mixture of the characteristics found in the specimens shown in figs. 1 and 3. It closely resembles the specimen of *T. major* shown in Plate **2**, fig. 1. Length 266 mm. Width 184 mm.

Fig. 3. *Terrapene canaliculata* Hay. Melbourne, Florida, M.C.Z. 1026. This individual closely resembles the specimen of *T. major* figured in Plate **2**, figs. 2 and 3. Length 239 mm. Width 169 mm.

Fig. 4. *Terrapene canaliculata* Hay. Melbourne, Florida, M.C.Z. 1027. This individual is on the general plan of fig. 3, but has differently shaped vertebral scutes, deeply incised sulci, very strongly developed dorsal keel, and a shallowly excavated nuchal border. Length 232 mm. Width 167 mm.

Fig. 5. *Terrapene canaliculata* Hay. Melbourne, Florida. M.C.Z. 1028. A young individual, with the characteristics of fig. 2. It shows very close correspondence to the fragmentary type of *T. formosa* Hay. Length 156 mm. Width 114 mm.

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PLATE 2

PLATE 2

Fig. 1. *Terrapene major* Ag. Florida. M.C.Z. 1507. Cotype. Note the smoothly oval shape of the carapace as contrasted with fig. 3. In profile it slopes evenly. The greatest height is at mid-length. Compare with fig. 2. Length 163 mm. Width 116 mm.

Fig. 2. *Terrapene major* Ag. Florida. M.C.Z. 1506. Cotype. Note the extreme flare of the posterior peripherals and the heavy lateral keel. Greatest height is posterior to mid-length. Length 153. Width 110.

Fig. 3. Dorsal view of fig. 2.

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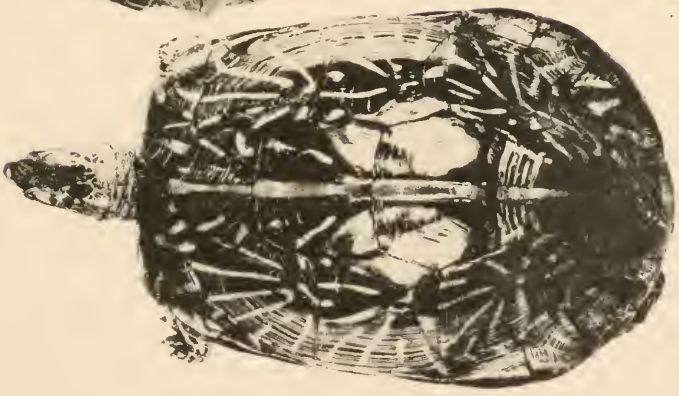

3

PLATE 3

PLATE 3

Fig. 1. *Terrapene major* Ag. Florida. M.C.Z. 1505. Cotype. Note the smoothly oval shape of the carapace and the lack of flare of the posterior peripherals. Length 138 mm. Width 104 mm.

Fig. 2. *Terrapene major* Ag. Royal Palm Hammock, Florida. M.C.Z. 12499. The general proportions of this carapace is very like that of *T. singletoni*. Length 110 mm. Width 80 mm.

Fig. 3. *Terrapene major* Ag. Homestead, Florida. U.S.N.M. 61699. A small individual resembling Plate **2**, fig. 3. Note the unusual shape of the first vertebral scute. Length 113.5 mm. Width 79.5 mm.

Fig. 4. *Terrapene major* Ag. Kissimmee, Florida. U.S.N.M. 72239. A carapace with very robust proportions. Note the strongly flaring peripherals. Compare with fig. 1. Length 126 mm. Width 106 mm.

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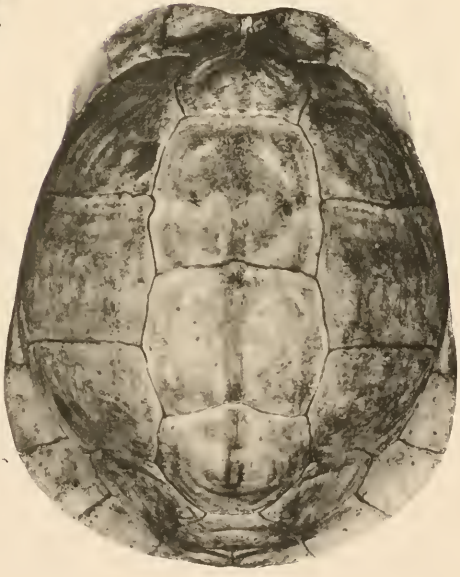

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THE ORNITHOLOGY OF THE CARIBBEAN COAST OF EXTREME EASTERN PANAMA

BY LUDLOW GRISCOM

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No. 9.—*The Ornithology of the Caribbean Coast of Extreme Eastern Panama*

By Ludlow Griscom

For some years Mr. H. Wedel has been collecting birds in the Almirante region of western Panama, originally under the auspices of Mr. Frederick H. Kennard and finally directly for this Museum. He was signally successful in securing rarities and novelties, and the final report on his collections has just been published by Mr. Peters (Bull. Mus. Comp. Zoöl., **71**, No. 5, 1930).

Early in 1929 it became increasingly apparent that it would no longer pay the Museum to purchase additional specimens from this region on any basis which would adequately remunerate the collector. Accordingly I suggested to Mr. Wedel that he should proceed to the Caribbean coast of extreme eastern Panama, where a virgin field awaited him in the Tropical Zone, even if he were unable to reach Subtropical Zone altitudes.

So far as I am aware, no authentically labeled bird skins are in existence from the Caribbean coast of eastern Panama east of Porto Bello, or no report on them has ever been published. The old Michler Expedition brought back birds from the Rio Truando in northwestern Colombia. This river is of Caribbean drainage, and is some thirty miles south of the present Panama boundary. The records are included in the volumes of Ridgway's Birds of North and Middle America, and also in the Biologia Centrali-Americana, but it should be remembered that they do not really belong either to Panama or Middle America. A good many of the species have since been found in Panama, but the Ant bird, *Sakesphorus canadensis pulchellus*, is an example of a species which has yet to be recorded definitely from Middle America.

In 1877 the Paris Museum received a collection of birds from Dr. Viguier made "along the borders of the Gulf of Darien." This collection contained the unique type of *Dacnis viguieri*, but has never been reported upon. It is quite possible, however, that some or all of the birds were actually collected on the Caribbean coast of eastern Panama.

After considerable correspondence, Mr. Wedel decided to go to Permé, where he arrived on March 14, 1929. Permé is not shown on most Panama maps, but is about five miles west of Anachucuna, at the head of the bay of the same name, and not more than twenty-five miles from the Colombian border. Permé is a small plantation of the

United Fruit Co., and it is quite obvious that the country in the immediate vicinity of the station is largely cleared for agriculture. A mile or so back of the village, however, virgin forest begins, and Wedel complained that the "bush" was much denser and more impenetrable than at Almirante. He was also hampered by the humid climate, as heavy rains began the middle of April and lasted until the following January.

While geographically ideal, Permé had the disadvantage of being so small a place that there were practically no facilities of any kind, and no labor. The Indians were peaceable and friendly, but would not work as porters or guides, nor would the few Colombians attached to the plantation. It also proved very difficult to send funds to Mr. Wedel. They had a way of remaining indefinitely at Colon or Cristobal, and he was severely handicapped all during the summer, and suffered considerable hardship.

Mr. Wedel's report of August 12 contains some interesting information and a sketch map of the region. The few Indian trails, shown by dotted lines, are absolutely impassable except during the height of the dry season, and to go anywhere else involves the painful ascent of a steep water course, a condition of affairs which tallies perfectly with Goldman's experience near Porto Bello in his effort to reach the Cerro Brujo. As elsewhere along the Caribbean coast of eastern Panama, the mountains rise with great steepness and suddenness from a very narrow coastal plain, which the Indians have largely denuded of game. The higher altitudes in the interior are cut off from the coast by one or two intervening ridges, which have to be ascended and descended, and all is covered with a jungle so dense that a trail must be cut, if none exists.

These conditions will have a familiar ring to those who have had field experience in the mountains of Panama. They call for expert camping and organizing ability and the knack of handling the lazy and shiftless native labor, the only kind available. Wedel made several efforts to camp in the mountains, but failure dogged his footsteps. One accident or another occurred, or his porters deserted after one or two days in the bush. He consequently never collected above 1,500 ft., but sent in large series of beautifully prepared specimens from the primeval wilderness back of the coast.

Heavy rain did not cease until the first week of January, 1930, at which time Wedel had only one gun in working order. A further chapter of accidents prevented an expedition into the mountains during the dry season, and Wedel decided to leave Permé, and moved to Obaldia, where there is a United States naval radio station. In the

meantime his boy accidentally shot a native woman in the foot, and the Panama government confiscated his remaining gun, so for a period of seven weeks Wedel was unable to collect at all.

The avifauna at Obaldia proved to be precisely the same as at Permé. The various reasons which prevented reaching the mountains back of Permé applied with equal force at Obaldia. Wedel collected to within a half mile of the Colombian boundary, and obtained a thorough representation of the bird life in the general neighborhood from sea level to 1,500 ft. Operations were accordingly discontinued in March, 1931, and Wedel returned to the Canal Zone.

The collection as a whole totals 1,396 skins, referable to 284 species. While this is by no means a complete list for the Tropical Zone, it is a thoroughly representative one, and is amply sufficient to give an idea of the avifauna and its geographical affinities. The outstanding results may be summarized as follows:

(1) Many genera and species, characteristic of the Colombian-Pacific fauna, and hitherto known only from the Pacific coast from west Ecuador to Darien, are shown to reach the Caribbean coast, a northward and eastward extension of their range.

(2) Confirmatory evidence of the Amazonian pre-Andean origin of this fauna is consequently provided (cf. Chapman, Dist. Bird Life Colombia, introduction).

(3) The region is faunally the connecting link between the Cauca-Magdalena and the Colombian-Pacific faunas. The list appended below contains illustrations of these points.

Rhynchortyx cinctus hypopius
Geranospizias caeruleseens balzarensis
Chalybura urochrysa incognita
Trogon violaceus caligatus
Xenornis setifrons
Chloropipo holochlora suffusa
Sapayoa aenigma
Thryophilus nigricapillus reditus
Thryophilus leucopogon
Thryophilus leucotis
Hylophilus ochraceiceps bulunensis
Hylophilus minor darienensis

(4) In the case of species of wider distribution which are notably variable, the racial affinities of Permé and Obaldia birds lie more often with the Colombian rather than the Canal Zone subspecies. The pro-

portion, however, is not as high as it is on the Pacific side of Darien.

(5) The surprisingly large number of new forms from this area is due to all the factors listed above. In many cases the extreme humidity of the climate is correlated with the darker or more saturated coloration of the birds. Where this is not the case, it is noteworthy that the new forms never have characters which are intermediate between those shown by their geographically adjacent relatives. The violet throat of the new *Lepidopyga*, for instance, is a different mutation from the characters separating the blue-throated races on each side of it.

(6) In addition to the new races described, the following species and subspecies are new to Panama.

Morphnus taeniatus
Rostrhamus sociabilis
Chordeiles minor sennetti
Chaetura spinicauda spinicauda
Anthoscenus longirostris stuartae
Trogon violaceus caligatus
Megarhynchus pitangua pitangua
Petrochelidon lunifrons melanogaster
Microbates cinereiventris magdalenae
Thryophilus leucotis leucotis

(7) The following species prove to intergrade:

(a) *Ortalis garrula* and *cinereiceps*
(b) *Cochlearius cochlearius* and *zeledoni*
(c) *Dendrocygna autumnalis* and *discolor*

(8) Wedel collected North American migrants very intelligently, and the region is obviously a main highway for them. Many of the species are rare or unknown in Central America. A list of the more interesting is appended.

Sterna sandvicensis acuflavida
Limnodromus griseus griseus
Chordeiles minor minor
Chordeiles minor sennetti
Coccyzus americanus
Coccyzus erythrophthalmus
Tyrannus dominicensis
Riparia riparia
Petrochelidon lunifrons melanogaster
Vireo calidris barbatula
Dolichonyx oryzivorus

Systematic List

TINAMIDAE

Tinamus major saturatus Griscom

Permé, 5 ♂, 5 ♀; Obaldia, 4 ♂, 2 ♀; Ranchon, 2 ♂, 3 ♀.

This fine series abundantly confirms the characters of this recently proposed form (cf. Griscom, Bull. Mus. Comp. Zoöl., **69**, No. 8, 1929, pp. 150–152).

Crypturellus soui harterti Brabourne and Chubb

Since Carriker (Birds Costa Rica, pp. 378–380) revised the Central American races of this exasperating little Tinamou, large series have accumulated both in Cambridge and New York. The chief discovery in recent years was the existence of a marked sexual difference in color, as well as color phases in both sexes. These points as regards Central American birds have been ably summarized by my colleague Mr. Peters in his recent and final paper on the birds of the Almirante Bay region (cf. Bull. Mus. Comp. Zoöl., **71**, No. 5, 1931, pp. 296–297). In this same paper he referred the two specimens from this region to *modestus*, though we were well aware that they did not "fit" exactly. The series here reported upon came in at the time his paper was completed, but he kindly left the final elucidation of birds from the Caribbean lowlands of Panama to me.

In so difficult and variable a bird as *Crypturellus soui*, it would be inexcusable to record another race from Central America, without thorough comparison with several other recently proposed but little known races from adjacent parts of northern South America. This could not be done in Cambridge. I accordingly took an ample series to New York, where, thanks to Dr. Chapman's courtesy, I was able to reëxamine the extensive material in his care. The variations of *C. soui* in eastern South America must be left to someone else, but in Central America and the Andean region of South America, I have directly compared the types of six races, topotypes of the others, and have examined a total of 139 specimens. From Colombia, however, my material is entirely inadequate for a final revision of the various races involved, and I am by no means convinced that the distinctive characters of one or two are not really the accident of small series. Entirely apart from this point, we are dealing with one of the most geographically variable of Neotropical birds. Unlike *Buteo* (*Rupornis*)

magnirostris, a similar case, the sexes are often quite different, the immature plumage is also different, and there are color phases known in several races. It is not surprising, therefore, that one or more of the races, while separable from their nearest geographical allies, prove scarcely distinguishable from one sex or another of a more distant subspecies. A final and precise definition of each race would seem to be impossible. The following synopsis merely attempts to set forth the facts gleaned from an examination of the material before me.

1. *soui* (Hermann). Based on Guiana and Surinam material only. Sexes radically different, the females strongly rufous; size slightly smaller. Female: pileum and primaries blackish; above dark rich chestnut rufous; very tawny below; no dark band across chest; thighs very obscurely barred; throat white, strongly tinged with ochraceous. Male: above rich umber brown; pileum and primaries blackish; chest and sides strongly washed with dark brown, strongly contrasted with ochraceous abdomen and cinnamomeous chest.

2. *mustelinus* (Bangs). Santa Marta region and part of Venezuela *fide* Todd. The most rufescent and palest race. Female: slightly paler above than *soui*, the pileum brownish, not sooty. Male: slightly paler, above less rufescent, below more buffy, less tawny. Type and five others examined.

3. *caucae* (Chapman). Cauca and Magdalena Valleys. An unsatisfactory transitional form, connecting the pale rufous *mustelinus* with the darker less rufous birds of eastern Panama and northwestern Colombia. Female: darker than *mustelinus*, with sooty pileum and consequently readily separable, but certainly separable from *soui* only in having a dusky wash across chest. Male: scarcely separable from *mustelinus* below, a little paler than *soui*; above browner, less rufescent than *mustelinus*, foreshadowing the males of the Panama races with no rufous tinge in the upperparts at all. Type and seven others examined.

4. *caquetae* (Chapman). Amazonian Colombia. Another transitional form between *mustelinus* and *soui* to the dark extreme *nigriceps* of eastern Ecuador. It might be described as two thirds of the way from *mustelinus* to *nigriceps*, while *caucae* is only one third of the way from *mustelinus* to *harterti*. Female: obviously darker and browner above than *mustelinus*, pileum sooty, chest with a dusky band; below darker and richer in tone; a little darker and browner than *soui*, with a dusky chest band; slightly browner and darker than *caucae*. Male: much darker and browner above than *mustelinus*, darker ochraceous, less tawny below; browner and darker in lesser degree than *caucae*, and

browner but scarcely darker than *soui* above and not surely separable below. The type and two other specimens do not permit of a better diagnosis.

5. *nigriceps* (Chapman). Amazonian Ecuador. Darkest extreme, a very well marked form. Even darker than *caquetae*, but pileum and primaries blacker; both sexes more deeply colored above and below, the female with a dark chestnut brown tone above, and a chestnut rather than tawny or ochraceous tinge on the chest. The type and thirteen other specimens.

6. *harterti* Brabourne and Chubb. Western Ecuador through western Colombia to extreme eastern Panama (Pacific slope) and the whole of Panama on the Caribbean slope to Almirante. Connecting the more rufous South American races with the browner or duskier Central American races. Nearest *caucae* of all the preceding subspecies. Female: noticeably more grayish brown, less rufescent above than *caucae*, much less richly rufescent below; grayer, less orange tawny on breast and chest. Male: the darkest and sootiest race next to *nigriceps*; closest to *caquetae* in general coloration, differing below only in having the flanks and thighs much less heavily barred; above greyer, less umber-brown; not so dark as *nigriceps*, sootier, much less chestnut above; obviously much darker throughout than *caucae* and greyer less ochraceous below. Ecuador, 14; northwestern Colombia, 1; eastern Panama, 23; western Panama (Almirante), 3.

A well marked subspecies, amply distinct and easily separable from all contiguous forms. I was at one time inclined to describe Panama specimens as distinct, but now that I have seen far larger series of all the races combined, prefer a more conservative course. Females are not really distinguishable, but there is no doubt that the males average darker and sootier than the West Ecuador series. This series is, however, mainly from the drier parts of West Ecuador, while *harterti* was described from the humid northwest corner. A comparable series from Vaqueria might not prove separable from the Panama birds in the least. On the other hand, the degree of difference between the two extremes is less than the difference between *harterti* and its geographically adjacent allies, so I see little point in adding another subspecies to a bird so thoroughly divided already.

7. *panamensis* (Carriker). Pacific slope of Panama from Veraguas to Cape Garachiné on the coast of eastern Darien. Birds from the more humid *interior* of the upper Tuyra Valley are nearer *harterti*. A paler and duller bird than *harterti*, with less contrast between the sexes, the pileum brown, not sooty. Female: browner, less rufous

above, paler and duller below with less contrast between center of abdomen and flanks. Male: much paler than *harterti*, browner, less sooty above; duller and paler below, not so sooty on chest and sides and not so pale on center of abdomen, consequently more uniform below; close also to *caucae*, which is rufescent above, and brighter ochraceous below. Type and twenty-three other specimens examined.

8. *modestus* (Cabanis). Whole of Costa Rica and western Chiriqui (Pacific slope). Very different from any other race in that the sexes are practically alike and there is no rufous phase. Female: pileum blackish; above seal brown, not chestnut brown as in *panamensis*; below brownish fulvous with a strong grey or pale sooty wash except center of abdomen. Male: above much greyer, less brown than *panamensis*; below dirty greyish brown with a slight pale ochraceous tinge. A total of twenty-one specimens examined.

9. *meserythrus* (Sclater). Eastern Central America from Vera Cruz to southeastern Nicaragua. A much more richly colored race, with marked sexual difference in color. Female: upperparts very slightly darker than *modestus*, but becoming chestnut rufous on upper tail coverts. Secondaries and tertials broadly edged and tipped with rufous, recalling South American races; below bright ochraceous on abdomen, strongly rich cinnamon on chest, sides and flanks; thus totally different from *modestus*; nearer *panamensis*, but far brighter and more rufescent. Male: very close to *panamensis*, but brighter cinnamon ochraceous below.

To show how complicated is the diagnosis of the races of this Tinamou, I should like to point out that the *male* of *meserythrus* is exceedingly close to the *female* of *modestus*, while the *female* of *meserythrus* is separable from the *male* of *soui* of Guiana only in having less pronounced barring on flanks and thighs. A total of twenty-two specimens examined.

PHALACROCORACIDAE

Phalacrocorax olivaceus olivaceus (Humboldt)

Permé, 1 ♂ imm.

ARDEIDAE

Ardea herodias herodias Linnaeus

Permé, 1 ♂, 2 ♀; Obaldia, 1 ♂.

These are immature birds taken in November and December.

Butorides virescens maculatus Boddaert

Permé, 1 ♂, 1 ♀; Obaldia, 1 ?.

These birds were captured in August and one on July 2, a date which argues for their having been raised in the immediate vicinity. If the Green Heron breeds so far east of the Canal Zone, further evidence of the specific distinctness of *virescens* and *striata* is afforded.

Nyctanassa violacea (Linnaeus)

Permé, 3 ♀ immature; Obaldia, 1 ♂ ad., 1 ♀ imm.

Tigrisoma lineatum (Boddaert)

Obaldia, 1 ♂, 1 ♀, imm.; Ranchon, 1 ♂, 1 ♀ ad., 1 ? imm.

Heterocnus cabanisi (Heine)

Permé, 1 ♂.

The range of this Tiger Bittern has now been extended to within a few miles of the Colombian border, and it will surely be found there in time.

Cochlearius cochlearius panamensis Griscom

Permé, 1 ♂ imm.

This specimen, from a critical locality geographically, proves to be of considerable interest, as it connects the very distinct immature plumages of *cochlearius* and *panamensis*. The former is uniform rufous above, the latter is devoid of the slightest rusty tinge. The present specimen is exactly intermediate, as it is strongly washed with rusty above, but is nearer *panamensis* in having generally darker underparts. No matter what name it is given, it affords definite evidence that *zeledoni*, *panamensis* and *cochlearius* are all representative forms. The last has been found as far northwest as Remedios in the Magdalena Valley.

CICONIIDAE

Mycteria americana Linnaeus

Obaldia, 1 ♀.

ANATIDAE

Querquedula discors (Linnaeus)

Obaldia, 1 ♀, Nov. 26.

Dendrocygna autumnalis discolor Sclater and Salvin

Permé, 1 ♂.

This specimen is exactly intermediate between *autumnalis* and *discolor*, which are merely representative forms. Specimens from Veraguas in the American Museum are also intermediate, as is a specimen from Divala, Chiriqui, recorded as *discolor*. The latter race has no proper place in the list of Panama birds.

ACCIPITRIDAE

Elanoides forficatus yetapa Bonn. and Vieillot

Obaldia, 3 ♂, 2 ♀.

Odontriorchis palliatus (Wied)

Permé, 1 ♂, 2 ♀; Obaldia, 1 ♂, 1 ♀.

The Obaldia ♀ is in a most remarkable melanistic phase. The entire body, head and wings blackish brown, blacker on head and chest; wing feathers tipped with rusty; tail ashy brown with three black bars; underparts increasingly flammulated with white from chest to vent; under tail coverts white with broad rufous shaft stripes.

An examination of nearly fifty specimens from the entire range, including topotypes from Mexico and Brazil makes me unable to confirm the constancy of any of the size or color characters used by Swann to divide this bird into three subspecies. As usual in widely ranging Neotropical hawks, extreme northern and southern birds are larger than those geographically intermediate. Swann overlooked the fact that fully adult males and females are not exactly alike, and his other color characters are matters of individual variation.

Incidentally the type of *palliatus* Wied is in the American Museum, and is in what Sharpe calls the intermediate plumage. Swann erred in designating Matto Grosso as the type locality, with the type in the Leyden Museum, misled no doubt by Dr. J. A. Allen, who failed to find the specimen, when he described the Maximilian types. As Wied

speaks in his Beitrage (vol. 3, p. 152) of having obtained a single specimen only, on the Rio Peruhypé near Villa Viçoza, this may be accepted as the true type locality.

Harpagus bidentatus fasciatus Lawrence

Permé, 1 ♂ imm.; Obaldia, 1 ♂ ad.

Ictinia plumbea (Gmelin)

Permé, 2 ♂, 4 ♀, 1 ?; Obaldia, 1 ♂, 2 ?.

Rostrhamus sociabilis sociabilis (Vieillot)

Permé, 1 ♀.

Obviously the smaller South American form. The species is here recorded from Panama for the first time.

Accipiter superciliosus exitiosus Bangs and Penard

Obaldia, 1 ♂.

Apparently the first capture of this very rare little Sparrow Hawk for Darien, and the third for Panama.

Heterospizias meridionalis (Latham)

Permé, 1 ♂.

Buteo platypterus platypterus (Vieillot)

Permé, 8 ♂, 1 ?, Oct. 19–March 16; Obaldia, 2 ♂; Ranchon, 1 ♂.

Buteo albonotatus albonotatus Gray

Permé, 1 ♀, Aug. 7, 1929.

We still have things to learn about the Zone-tailed Hawk. The two races are by no means distinct, and the smaller South American subspecies *abbreviatus* Cabanis is too rare in collections for its size variation to be known. Indeed, Swann was unable to furnish measurements of females. The present specimen is well within the recorded measurements for females of the northern form. This is definitely known to breed south to the mountains of northern Nicaragua, and occurs in Costa Rica as a rare winter visitant. The only record of this species

for Panama is one from the Pearl Islands, and this specimen is the small *abbreviatus*. This apparently logical distribution is, however, upset by the specimen here recorded, as the date of its capture in tropical lowlands precludes its being a winter migrant.

Buteo brachyurus Vieillot

Permé, 1 ? melanistic.

Buteo magnirostris insidiatrix (Bangs and Penard)

Permé, 5 ♂, 4 ♀.

This race was recently added to the Panama avifauna by Peters and Griscom (Proc. N E Zoöl. Club, **11**, 1930, p. 48) on the material here listed.

Asturina nitida costaricensis Swann

Permé, 6 ♂, 2 ♀, 1 ?; Obaldia, 1 ♀.

These specimens are inseparable from the type of *costaricensis* Swann, and others from Veraguas and the Canal Zone belong here also. The race is well marked and fully entitled to recognition.

Leucopternis plumbea Salvin

Permé, 1 ♂, 1 ♀.

Leucopternis semiplumbea Lawrence

Permé, 1 ♂, 1 ♀; Ranchon, 1 ♂.

Leucopternis ghiesbreghti costaricensis W. L. Sclater

Permé, 4 ♂, 1 ♀, 1 ?; Obaldia, 2 ♂, 2 ♀.

Hypomorphus urubitinga urubitinga (Gmelin)

Permé, 1 ♀.

The Central American *ridgwayi* has well marked color characters in the adult plumage, but I know of none to distinguish the immature. Size characters are most unsatisfactory in this species. Specimens from Chile, Argentina, and Brazil are as large as *ridgwayi*; others from Surinam agree with Ecuador and Colombia specimens. The average

difference of *occidentalis* Swann is no greater than the range of individual variation in the species. Those who wish to recognize *occidentalis* must refer the Permé specimen to that form.

Buteogallus antiiracinus anthracinus (Lichtenstein)

Permé, 8 ♂, 3 ♀, 2 ?.

Morphnus guianensis (Daudin)

Obaldia, 1 ♀ nearly adult.

Morphnus taeniatus Gurney

Permé, 1 ♀.

This is the third specimen of this so-called species to be recorded. Lack of material makes it still impossible to settle its status with any degree of finality, but certain comments are in order. The present specimen and the one in the American Museum of Natural History from San José, eastern Ecuador, are both older birds than the type in the British Museum (also from eastern Ecuador), which is much browner both above and below, while the one before me is jet black. This is an entirely consistent sequence of plumages, which is well known in other hawks of this subfamily, which have a black plumage when fully mature. We, of course, know nothing about the immature plumages of *Morphnus taeniatus*.

The other species, *M. guianensis* (Daudin), is sufficiently well known to summarize its plumage sequence in a few words. The immature plumage closely resembles the juvenal and is a light hoary gray above and pure white below, with a ten to twelve barred tail. Over an uncertain period of years the adult plumage is gradually acquired, which is slaty or brownish black above, with a decreasing amount of light tipping to the crest feathers and freckling on the wing feathers. The adult tail is black with three to five ashy bands. The chin and throat are white, the chest ashy-brown, and the underparts white, lightly and sparsely barred with brownish or rufous. Adult males are grayer above, more ashy on the chest, with browner bars reduced in number. Adult females are browner above, browner on the chest, more barred, and the barring more rufous. I have seen specimens from eastern Honduras, eastern Costa Rica, western Panama (Caribbean slope), eastern Panama (both slopes) and Surinam, and all are in one plumage or the other described above, or in an obvious transitional stage.

Specimens in other museums have frequently been described or figured and living birds have been watched in zoölogical gardens in Europe, but throughout this extensive range, no specimen has ever been taken, which in the slightest respect approaches the plumage described as *M. taeniatus*. We also know that neither plumage of the *guianensis* type has been found in eastern Ecuador, and the bird breeds in the second stage.

The capture of *M. taeniatus* in eastern Panama obviously destroys any claims to its having a separate range, and weakens the evidence as to its specific validity, though this is not proved to be impossible. It will be apparent that *taeniatus* might be the real fully adult plumage of *guianensis*, but it would be a most extraordinary and unlikely coincidence that only three adult specimens had ever been captured. A far more likely possibility is that *taeniatus* is a black phase of *guianensis*. We may recall that this suggestion has been made with respect to *Spizaëtus tyrannus* and *ornatus*, but in that case the suggestion had greater validity because the ranges of the two birds were exactly the same. Todd, however, has recently shown (Birds of Santa Marta, p. 157) that there are both definite and proportionate size differences between them, and these do not exist in *Morphnus*.

On the evidence presented above, I regard it quite impossible for *taeniatus* to be a race of *guianensis*, as suggested by Swann (Monog. Accipitres, pt. 8).

Circus cyaneus hudsonius (Linnaeus)

Permé, 2 ♂, 1 ♀, 1 on Oct. 16, 1929.

Geranospizias caerulescens balzarensis W. L. Sclater

Permé, 2 ♂, 1 ♀, 2 ?.

Chapman (Birds Ecuador, 1926, p. 223) has already shown that specimens from eastern Panama belong to this recently described form.

Pandion haliaëtus carolinensis (Gmelin)

Permé, 1 ♀, Dec. 2, 1929; Obaldia, 1 ♀, Oct. 25, 1930.

FALCONIDAE

Micrastur melanoleucus naso (Lesson)

Permé, 1 ♂, 1 ♀; Obaldia, 1 ♂.

Micrastur mirandollei (Schlegel)

Permé, 3 ♂, 1 ♀; Obaldia, 1 ♀.

A series of five specimens of this very rare Hawk from one locality is unprecedented. The plumage sequence is somewhat like that of *melanoleucus*. The sexes are approximately alike, and there is an intermediate plumage with the underparts pale ochraceous fawn, some of the chest feathers with dark shaft stripes, and others on the sides of the breast with dusky borders, a survival of the juvenal plumage. The immature has never been described and is a most striking bird. The underparts are white, strongly tinged with pale buff, except on chin and vent. Every feather of the throat, chest, sides, flanks and abdomen has a broad border of dusky slate, affecting the terminal half, giving a very pronounced, scalloped effect.

Micrastur ruficollis interstes Bangs

Permé, 1 ♂, 1 ♀.

I am unable to recognize the genus *Climacocercus*. This group has been badly in need of revision for years. The race *interstes* Bangs is easily tenable and ranges south to West Ecuador. Chiefly east of the Andes occasional specimens have a tinge of brown or rufous on the foreneck, and others have brownish rather than slate upperparts. The last character is probably a sub-adult stage, as it can be found in a series of *guerilla* or *guerilla interstes*, and one specimen from Divalá, Chiriqui has a tinge of brown on the throat also, showing that this character is mutational. The name *zonothorax* Cabanis was applied to such a brown-throated bird, but I have seen one from near the type locality which has no brown. There is no species *zonothorax* ranging from Chiriqui to Venezuela, but there is a race of *guerilla* in Santa Marta, Venezuela and eastern Ecuador, which is much paler slate above than *guerilla* or *interstes*, but heavily barred below as in *interstes*. The immature in series is less heavily barred below than in *guerilla* or *interestes*, and is never so dark a buff or fawn color below. This race must be known as *zonothorax*, of which *jugularis* Gurney is a synonym. This bird is really an intermediate between *guerilla* and *ruficollis* and *gilvicollis*. In the former the tendency to a brownish or rufescent throat and chest is carried to an extreme, more or less constant, and in the latter we have a paler bird less heavily barred below. In the entire group the presence of three, four or five bars on the tail is a matter of individual variation.

Ibycter americanus americanus (Boddaert)

Obaldia, 1 ♂, 1 ♀; Ranchon, 1 ♀.

Falco albigularis Daudin

Permé, 1 ♂, 2 ♀, 1 ?; Obaldia, 2 ♂, 2 ?.

Cerchneis sparverius sparverius (Linnaeus)

Permé, 1 ♂, 3 ♀, the earliest Oct. 16, 1929.

CRACIDAE

Crax globicera Linnaeus

Permé, 1 ♂; Obaldia, 1 ♂, 2 ♀.

This genus is badly in need of revision. The two males here listed are fully adult as regards plumage, but lack the swollen knobs on the culmen. They are consequently inseparable from *C. fasciolata* Spix of eastern Brazil! In numerous Central American specimens examined, even in those dead many years, it is easily seen that the shrunken and dried knob on the culmen was pale yellow in life. On the same basis, I should say that the rudimentary knobs in the two birds here discussed were orange-red. I suspect that the presence or absence of knobs and wattles in males of this genus is an age or breeding season character and not specific. The white tipping of the tail is a character of immaturity, and a blue versus a greenish gloss is probably racial rather than specific. If Grant's assumption that immature males in this genus may have rudimentary wattles is correct, the two birds before me might also be *C. alberti* Fraser.

The two adult females are largely chestnut rufous above, with only a faint sooty tinge on the upper back, and there are a few faint blackish bars on the secondaries. The tail of one bird is what Grant calls "adult *panamensis*" or "immature *globicera*." The other is moulting the tail, and the new feathers are what Grant calls "adult *globicera*."

Penelope purpurascens aequatorialis Salvadori

Ranchon. 1 ♂

Ortalis garrula mira, subsp. nov.

Type.— No. 156,508, Museum of Comparative Zoölogy, ♂ ad.;

Ranchon, Caribbean slope of extreme eastern Panama; January 20, 1931; H. Wedel.

Characters.— Exactly intermediate between and connecting *O. garrula* of the arid north coast of Colombia and *O. cinereiceps* of southern Central America; head and neck slaty as in *cinereiceps*, not rusty brown as in *garrula*; underparts below breast white as in *garrula*, with pale brownish grey under tail coverts, whereas the same areas in *cinereiceps* are pale buffy brown to bistre brown.

This Chachalaca is one of Wedel's more interesting discoveries, and it is most exceptional these days to establish the intergradation of two such apparently distinct species as those here discussed. It is apparent that *cinereiceps* and *garrula* are merely representative extremes of the humid and arid tropics respectively.

PERDICIDAE

Odontophorus guianensis marmoratus Gould

Obaldia, 3 ♂, 2 ♀; Permé, 5 ♂, 2 ♀, 2 ?; Ranchon, 1 ♀.

This series raises an interesting question which I am quite unable to solve. Quite recently in discussing six specimens from Cana, Pacific slope of Darien (Bull. Mus. Comp. Zoöl., **69**, 1929, p. 153) I described them as *chapmani*, differing from *panamensis* Chapman in being darker and more richly colored, darker grey on foreneck and breast, and tending to be more spotted, less barred on the underparts. Still more recently Chapman (Amer. Mus. Novit., No. 380, 1929, pp. 3–7) has given an interesting review of the species for the whole of northwestern South America. With seven specimens from Colombia before him, representing *marmoratus*, he commented on the great individual variation shown, and concluded that *panamensis* Chapman and *chapmani* Griscom were best treated as synonyms of *marmoratus* Gould. Not having seen the Colombian specimens, I gladly follow this conservative treatment here.

On the other hand, I now have nineteen specimens before me which represent *chapmani*, and the series listed above amply confirms the characters of that proposed form, when contrasted with a series from the Canal Zone east to Mt. Sapo. In fact, discounting the many ways in which individual variation runs riot in this Partridge, these two series are separable at a glance, and the degree of difference shown would be regarded as racial by any conservative systematist.

Canal Zone specimens are really intermediate between *castigatus* Bangs of (Pacific slope) Chiriqui, of which the type and fourteen others are before me, and the nineteen birds from extreme eastern Panama. This Partridge is by no means confined to the humid Tropical Zone, but occurs also in those parts called arid by Goldman, and it is in just these parts that paler and more uniformly colored birds occur. The rainfall is only 80 inches a year in the range of *castigatus*, and *panamensis* Chapman occurs near Panama City, where the rainfall is also about 80 inches. This arid strip stretches eastward on the Pacific coast to Cape Garachiné and Mt. Sapo, and a tongue goes up the Rio Tuyra to a little beyond El Real. While it is true that El Real is "only twenty-five miles" from Cana, it is on the border between the arid and the humid tropics, and the intermediate character of the specimen from there is exactly what one would expect. These conditions are quite different from those at Permé, Obaldia and Cana (at a higher altitude) where the rainfall is about 200 inches a year. The Tropical Zone of eastern Panama must not be thought of as a homogeneous region.

Dr. Chapman was the first to point out that his seven specimens from the whole of Colombia were scarcely comparable with the long series available from Panama, and emphasized the need of local series to distinguish racial from individual variation. Until such series are available from Colombia, the whole assemblage may well be called *marmoratus*.

Rhynchortyx cinctus hypopius, subsp. nov.

Type.— No. 155,038, Museum of Comparative Zoölogy; ♀ ad.; Obaldia, Caribbean slope, eastern Panama; August 12, 1930; H. Wedel, No. 2,618.

Characters.— The palest of all the known forms of the species; the male nearest *pudibundus* Peters of eastern Honduras, but even paler, paler ochraceous below, with far more pure white, which often occupies entire center of abdomen; thighs whitish, only faintly barred; rump and upper tail coverts greyer, less brown; female paler than typical *cinctus*, with much less barring below, the under tail coverts whitish with broad bars, instead of brownish with narrow bars, in which characters it also differs from *pudibundus*; in general coloration, however, darker and more barred than *pudibundus*; pileum rusty instead of brown with an olive tinge, the ear coverts rusty instead of sooty.

Material examined

pudibundus.— Eastern Honduras, 1 ♂, 2 ♀.

cinctus.— Good series from eastern Nicaragua and Darien (Pacific slope).

hypopius.— Darien, Caribbean slope, Obaldia, 3 ♂, 2 ♀; Permé 2 ♂.

This striking distinct form requires no further comment. The paleness of its coloration, however, would not be expected in so humid a region.

RALLIDAE

Aramides cajanea cajanea (P. L. S. Muller)

Permé, 1 ♂, 2 ♀.

Creciscus albigularis (Lawrence)

Permé, 2 ♂, 1 ♀.

Ionornis martinica (Linnaeus)

Permé, 1 ♂.

EURYPYGIDAE

Eurypyga major major Hartlaub

Permé, 1 ♂.

JACANIDAE

Jacana nigra (Gmelin)

Permé, 1 ♀.

CHARADRIIDAE

Squatarola squatarola (Linnaeus)

Permé, 2 ♂.

Oxyechus vociferus vociferus (Linnaeus)

Permé, 1 ♀.

Charadrius semipalmatus Bonaparte

Permé, 1 ?.

SCOLOPACIDAE

Himantopus mexicanus (P. L. S. Muller)

Permé, 1 ♂.

Limnodromus griseus griseus (Gmelin)

Permé, 1 ♂.

The second capture of this race in Panama.

Tringa solitaria solitaria Wilson

Permé, 1 ♀, July 29, 1929.

Capella delicata (Ordway)

Permé, 1 ♀, Oct. 25, 1929.

LARIDAE

Sterna sandvicensis acuflavida Cabot

Permé, 1 ?, Nov. 30, 1929.

I am aware of only one previous capture of Cabot's Tern in Panama.

COLUMBIDAE

Columba rufina pallidicrissa Chubb

Permé, 1 ♂.

Columbigallina rufipennis rufipennis (Bonaparte)

Permé, 11 ♂, 1 ♀.

Claravis pretiosa pretiosa (Ferrari-Perez)

Permé, 3 ♂, 1 ♀; Obaldia, 1 ♂.

These birds are intermediate between *pretiosa* from southern Mexico and the types of *livida* Bangs, and might as well be referred to one race as the other. Perhaps the best course would be to restrict *livida* to the Cauca Valley, and call all birds from eastern Panama *pretiosa*.

Leptotila cassini cassini Lawrence

Permé, 19 ♂, 10 ♀, 2 ?.

Oreopeleia montana (Linn.)

Permé, 1 ♀; Obaldia, 1 ♂.

Oreopeleia veraguensis (Lawrence)

Permé, 12 ♂, 3 ♀; Obaldia, 1 ♂; Ranchon, 3 ♂, 3 ♀:

A remarkably variable bird. All specimens with white forehead, gray on crown, grayer rather than browner breasts and paler brownish wash on abdomen are males. Two specimens marked ♂ are, however, like females in being browner with buffy foreheads. As Wedel's sexing is unusually reliable, these may be younger birds. Four males have the gloss strongly violet purple rather than greenish.

PSITTACIDAE

Ara chloroptera Gray

Permé, 1 ♀; Obaldia, 2 ♂.

Brotogerys jugularis jugularis (Müller)

Permé, 5 ♂, 4 ♀, 1 ?.

Amazona farinosa inornata (Salvadori)

Permé, 1 ♂, 2 ♀; Obaldia, 2 ♀.

Eucinetus haematotis coccineicollaris (Lawrence)

Permé, 1 ♂, 1 ♀; Obaldia, 2 ♂.

CUCULIDAE

Coccyzus americanus americanus (Linnaeus)

Permé, 1 ♂, Oct. 20, 1929; Obaldia, 1 ♀, Sept. 30.

Coccyzus erythrophthalmus (Wilson)

Permé, 1 ♂, Oct. 16, 1929.

PIAYA CAYANA INCINCTA subsp. nov.

Type.— No. 155,252, Museum of Comparative Zoölogy; ♂ ad.; Permé, Caribbean slope of Darien, eastern Panama; July 22, 1929; H. Wedel, No. 1,954.

Characters.— Easily separable from *thermophila* Sclater of Mexico and Central American in that the black tips to the tail feathers, particularly the middle pair, are only half as extensive and the under surface of the tail feathers is largely rufescent, tipped with blackish, instead of uniform blackish; also easily separable from *mesura* (Cabanis), the most closely related race in Colombia, which is much darker above, especially the tail, and the tail has no black tip whatever.

Material examined

thermophila.— Seventy specimens available at the moment from every part of the range from southern Mexico to southwestern Costa Rica and northeastern Panama.

stirtoni.— Salvador, 2 ♀, 1 ?.

incincta,— Pacific slope of Panama; Divalá, 1 ♂, 2 ♀; Boquete, 1 ♂, 1 ♀; near Panama City, 3 ♂, 2 ♀; Mt. Sapo, 1 ♀; Cana, 1 ♂, 3 ♀. Permé, 1 ♂.

In addition to the characters given above, there may also be some slight average color differences, but I am very suspicious of these the more specimens I examine. Very fresh examples of *thermophila* are darker above, the head is more rufous, less grayish brown, and there is a great deal of violet gloss on the scapulars and tertials. Worn birds lose this gloss, the color of the upperparts fades a little, and the crown particularly tends to become more or less grayish brown. At least one third of my specimens of *thermophila* are extremes of this sort but many show no special signs of wear. The three specimens of *stirtoni* are inseparable from these on color characters above. The variation in color below is much more individual, rather than seasonal. The only point of importance is the color of the ventral and anal regions which is dark slate in the great majority of individuals. In this respect, the three specimens of *stirtoni* are paler than the majority, but they are darker than four extremely pale birds from the Caribbean slope. In these particular characters, therefore, we are dealing with slight average differences only. A good series from western Guatemala is unquestionably *thermophila.*

Turning now to the series of *incincta,* a majority of two thirds are slightly darker above. None are as grey on the pileum as extremes of

thermophila, and in ten cases the pileum is not appreciably paler than the mantle. In these respects they approach *mesura*.

Three specimens from the Caribbean side of the Canal Zone are intermediate between *thermophila* and *incineta*. Two are decidedly nearer *incincta*; one might be called either.

Neomorphus salvini salvini Sclater

Permé, 1 ♀; Obaldia, 2 ♀.

Crotophaga major Gmelin

Permé, 6 ♂, 5 ♀.

Crotophaga ani Linnaeus

Permé, 2 ♀; Obaldia, 1 ♀.

BUBONIDAE

Pulsatrix perspicillata chapmani subsp. nov.

Type.— No. 155,173, Museum of Comparative Zoölogy; ♂ ad.; Permé, Caribbean slope of Darien, eastern Panama; May 2, 1929; H. Wedel.

Characters.— Differing from typical *perspicillata* (Latham) in being larger and darker; resembling *saturata* Ridgway from Oaxaca, Mexico, in these respects, but underparts devoid of barring entirely, or the barring confined to the border of the dark breast, which is broken instead of being a sharp line.

Material examined

perspicillata.— Surinam, 4 ♂, 6 ♀; Santa Marta, 1 ♂, 1 ♀; Peru, Perico, 1 ♀.

chapmani.— Colombia, near Cali, 1 ♀; Panama; Ranchon, 1 ♀; Permé, 2 ♂, 3 ♀; Obaldia, 1 ♂, 1 ♀; Canal Zone, Caribbean slope, 1 ♂, 1 ♀; Almirante Bay region, 1 ♂, 2 ♀; Costa Rica, Escazú, 1 ♂.

saturata.— 5 ♂, 3 ♀, from Pacific slope of western Panama and Costa Rica, Honduras, British Honduras and Guatemala.

This well marked intermediate race is appropriately named after Dr. Frank M. Chapman, who first pointed out its characters, subject to confirmation by additional material (cf. Birds Ecuador, 1926, p. 245). I have now examined over twenty specimens from Central

America, and all are more or less strongly barred underneath. Specimens from eastern Costa Rica and the Caribbean slope of western Panama are intermediate, but nearer *chapmani*, which ranges south through western Colombia to west Ecuador. I here restrict the range of *saturata* to southern Mexico and northern Central America, south on the Pacific slope to Chiriqui.

Lophostrix cristata wedeli subsp. nov.

Type.— No. 155,180, Museum of Comparative Zoölogy; ♀ ad., dark phase; Permé, Caribbean slope of Darien, eastern Panama; November 2, 1929; H. Wedel, No. 1,919.

Characters.— Appearing specifically distinct from typical *cristata* and very much darker than *stricklandi* Sclater and Salvin of Central America; pileum blackish; upperparts and wings blackish brown; the light freckling and spotting always darker buff, often with a distinct rufous tinge; chest and breast much darker, blackish brown, the mottling much coarser, giving a barred rather than a freckled effect; a greater or less patch of white in the center of the chest, lacking in the dark phase of the two other races, but present in the light phase; balance of underparts not differing from *stricklandi*, giving a far greater contrast between chest and abdomen.

Material examined

cristata.— Surinam, 1 ♂, dark phase; 2 ?, light phase.

wedeli.— Eastern Panama, Permé, 2 ♂, 2 ♀; Obaldia, 1 ?, all dark phase; Ranchon, 1 ♂, 1 ♀, dark phase.

stricklandi.— Costa Rica, 1 ♂, dark phase, 2 ♂, 1 ?, light phase; Divalá, western Chiriqui, 1 ♀, dark phase.

This surprising discovery is named after the collector, probably the only man who ever secured six specimens of this rare Owl in one region in less than a year. In spite of its intermediate geographic position, it is more different from *stricklandi* than is that form from *cristata*. The literature is confused on the phases of this Owl, and I append a summary of the differences between the three races. Ridgway's key is misleading, there is no rufous or hepatic phase, and his suspicion that there were two races in Central America, the dark phase on the Caribbean slope and the light phase on the Pacific slope, proves to be incorrect. I have myself collected the dark phase in Veraguas, and have seen others in the dark phase from the Pacific slope.

	Dark Phase	*Light Phase*
cristata	1. Pileum, upperparts and face uniformly dark rusty brown 2. Spotting and barring on wings whiter 3. Chest dark brown, no white patch 4. Underparts whiter and barring coarser	1. Above uniform light cinnamon brown 2. Orbital region bright rufous chestnut 3. Chest with white patch 4. Below generally paler
wedeli	1. Pileum blackish, upperparts blackish brown; face black, part of orbital region chestnut 2. Spotting and barring on wings buffier 3. Chest blackish brown, with central white patch 4. Underparts with little or no white, barring finer	Unknown
stricklandi	1. Pileum sooty, upperparts vandyke brown, face blackish, the rusty area greater 2. As in *wedeli* 3. Chest at most medium brown, no white patch 4. Freckled rather than barred throughout	1. Above darker cinnamon brown or snuff brown 2. Orbital region rufous passing to blackish brown 3. White chest patch much reduced 4. Below generally darker

Ciccaba virgata virgata (Cassin)

Permé, 3 ♂, 1 ♀.

Glaucidium minutissimum rarum Griscom

Permé, 1 ♂; Obaldia, 1 ♂.

For a systematic monograph of the rare little Pygmy Owl (cf. Griscom, Proc. N. E. Zoöl. Club, **12**, 1931, pp. 37–43).

NYCTIBIIDAE

Nyctibius griseus panamensis Ridgway

Permé, 1 ♀, 1 ? [= ♀].

CAPRIMULGIDAE

Caprimulgus rufus rufus Boddaert

Obaldia, 1 ♀.

Caprimulgus carolinensis Gmelin

Permé, 1 ♀, Nov. 3, 1929.

Chordeiles minor minor (Forster)

Permé, 1 ♂, Oct. 15, 1929.

Chordeiles minor sennetti Coues

Permé, 1 ♀, Oct. 18, 1929.

Not only is this specimen an addition to the avifauna of Panama, but it is the first authentic record of the race outside of the United States, so far as I am aware. Fortunately the bird is an extreme in the general pallor of its coloration.

Nyctidromus albicollis intercedens Griscom

Permé, 3 ♂, 1 ♀, 3 ?; Obaldia, 1 ♀.

MICROPODIDAE

Streptoprocne zonaris albicincta (Cabanis)

Permé, 1 ♀.

Chaetura spinicauda spinicauda (Temminck)

Permé, 3 ♂.

These specimens agree with others from Trinidad and Cayenne and also with others from the Cauca Valley, Colombia, which Chapman inadvertently determined as *fumosa*. While previously unrecorded

from Panama, it is probably this form which is so abundant on the Pearl Islands and the streets of Panama City. All specimens I have seen from the Pacific slope of western Panama are *fumosa*.

TROCHILIDAE

Threnetes ruckeri darienensis Bangs and Barbour

Permé, 4 ♂, 1 ♀; Obaldia, 5 ♂, 2 ♀; Ranchon, 2 ♂.

Glaucis hirsuta affinis Lawrence

Permé, 2 ♂, 3 ♀; Obaldia, 2 ♂.

Phoethornis superciliosa cassini Lawrence

Permé, 11 ♂, 1 ♀, 2 ?; Obaldia, 1 ♂; Ranchon, 2 ♂, 1 ?.

The Central American races of this species are in a most unsatisfactory condition, as the two intermediates were the first described. As a result we now have four races, two of which are very ill defined. The northern extreme *mexicanus* is the palest with white tipped outer tail feathers. Typical *longirostris* from Guatemala has buffy tips to the tail feathers. The so-called *cephala* from eastern Nicaragua is slightly darker and buffier below with faint barring. Specimens from eastern Costa Rica agree, as do others from Almirante, western Panama, but Canal Zone specimens are appreciably darker. Series from eastern Honduras are no darker than Guatemala specimens, but show the faint barring of *cephala*. They thus might be called either. As might be expected, series from southwestern Costa Rica are paler than birds from eastern Costa Rica, and consequently they are indistinguishable from the Honduras series. Either *longirostris* must be given a discontinuous distribution, or the name *cephala* must include elements which are easily separable from each other in series. Birds from Darien are a very dark extreme, *cassini*, which is far more distinct from *cephala* than is that race from *longirostris*.

Phoethornis longuemarea subrufescens Chapman

Permé, 2 ♂; Obaldia, 1 ♀, 1 ?; Ranchon, 1 ♂.

The small Hermits (subgenus *Pygmornis*) have suffered cruelly at the hands of specialists, and speciation has been greatly overdone. Not only has the same species been redescribed, but the same bird has

been listed as two different species by Simon, whose latest key is a marvel of ingenuity. The Central American *adolphi* is a representative of *striigularis*, a pale extreme of a drier climate, while the races of *adolphi* are more richly colored in more humid climates. The specific characters of *striigularis* disappear, however, in its Pacific coast representative *subrufescens* Chapman, which I am unable to separate from *adolphi fraterculus* Nelson of Cana, Darien, which was renamed *nelsoni* Bangs and Barbour. The specific distinctness of *striigularis* and *longuemarea* Lesson of the Guianas is bridged by *atrimentalis* Lawrence of Amazonian Ecuador, which Chapman has recently shown to be a representative of *striigularis*. Here, in the more humid Cis-Andine climate, we return to a richer coloration, the dusky streaks on the throat have coalesced into a sooty chin spot, and these characters reach their extreme development in *longuemarea*. Modern series show that this latter bird has a bicolored lower mandible in fresh specimens.

In this whole group reliably sexed specimens show that females are distinctly paler, less richly colored below than fully adult males. Younger males are colored like females, but the central tail feathers are not fully elongated.

Even with these suggested adjustments, the Central American races are unsatisfactory. While *subrufescens* is very different from *striigularis*, it is not trenchantly separable from *saturata*, nor is the latter abundantly distinct from *adolphi*. In series *saturata* averages darker and more richly colored than *subrufescens*, while *adolphi* is paler again and lacks the dusky chin spot.

Eutoxeres aquila munda subsp. nov.

Type.— No. 155,290, Museum of Comparative Zoölogy; ♂ ad.; Obaldia, Caribbean slope of Darien, eastern Panama; July 24, 1930; H. Wedel, No. 2,509.

Characters.— Nearest typical *aquila* Bourcier of eastern Colombia and Ecuador, but white tipping of tail the maximum for the species; underparts in adults entirely devoid of any buffy tinge, and the white streaking averages broader and more diffuse than in any other race; differing most of all from *salvini* Gould of Costa Rica and western Panama in being darker, less bronzy or golden green above, with bluish upper tail coverts, and white tipping of outer tail feathers wedge-shaped or irregular basally as in *aquila*, not evenly truncate, transverse or oblique as in *salvini*; wing in males, 73–79.

The fine series of twenty specimens of the new form, together with a

representation of all the other described races enables me, I think, to improve on the keys in Ridgway and the latest one in Simon's monograph. The races of *aquila* divide into two general groups; *aquila* and *munda* are darker green above with bluish upper tail coverts and wedge-shaped tail tips. The opposite extreme is *salvini*, which is golden or bronzy green above with transverse or oblique tail tips. The extent of the tipping is exceedingly variable as Chapman has shown, but *munda* averages more than any other race, and *heterura* of west Ecuador, intermediate in the characters given above, has the least.

As regards the underparts, *munda* represents one extreme in having no tinge of buff below and slightly broader streaking. All other races have some buffy tinge below and narrower streaking. In *aquila* and *salvini* the throat and breast are tinged with buffy, the belly usually whiter and quite contrasted with the breast. In *heterura* we have the other extreme, in which the entire underparts are usually tinged with buffy.

In past years when series were scarce or nonexistent and the genus was unknown in eastern Panama, specimens from the Pacific slope of western Colombia were referred to *salvini*. I have seen six in all, and three are now before me. They are indeed extraordinarily close to *salvini*, and this is exactly what we should expect. Western Colombia is geographically intermediate between Darien and west Ecuador, and an intermediate between *munda* and *heterura* would inevitably produce characters very like *salvini* in many respects. Were it not for a specimen from the Pacific side of Darien (Mt. Sapo), which is unquestionably *munda*, *salvini* might range to west Colombia on the Pacific slope. There is no recourse other than to describe a very slightly marked form.

Eutoxeres aquila viridior subsp. nov.

Type.— No. 124,576, Museum of Comparative Zoölogy; ♂ ad.; Naranjito, Rio Dagua, west Colombia; June 22, 1908; M. G. Palmer.

Characters.— Exceedingly close to *salvini* in nearly every respect, but slightly larger, upperparts much greener, not at all golden or bronzy, and tail conspicuously paler bronze, less green, as in *heterura*; wing 74–76, in *salvini*, 68–74.5; in *heterura* averaging 71.5.

Phaeochroa cuvierii cuvierii (Delattre and Bourcier)

Permé, 2 ♂.

These birds agree absolutely with a series of eleven from the Canal Zone, and show no approach whatever to *berlepschi* Hellmayr from

Barranquilla, of which *notia* Todd from Turbaco near Cartagena is apparently an accidental redescription.

Within narrow limits this Hummingbird is quite variable and of relatively local distribution in forested areas. So far as known, it is lacking in the savannah country between the Canal Zone and the Cape Mala Peninsula, but reappears in the heavy coastal forests of Veraguas, where I found it fairly common in 1924. These birds are apparently *saturatior* Hartert, which is not confined to Coiba Island. The species is again common in the wooded areas of western Costa Rica, and a fine series proves to be quite distinct from typical *cuvierii*. It may be described as

PHAEOCHROA CUVIERII MACULICAUDA subsp. nov.

Type.— No. 122,617, Museum of Comparative Zoölogy; ♂ ad.; Bolson, Costa Rica; December 10, 1907; C. F. Underwood.

Characters.— Differing from *cuvierii* of the Canal Zone in having the throat and breast greener, an effect produced by the reduction in the buff edgings to the feathers; the dusky bar on the outer tail feathers is twice as broad at least as in *cuvierii*, and is usually bluish black on the outer half and sharply contrasted with the bronzy base of the feather; wing averaging about five millimeters longer. Fifteen specimens examined.

It is largely a matter of opinion whether *P. roberti* of eastern Central America from Guatemala to eastern Nicaragua is specifically distinct. The solid dusky mandible is by no means constant. Simon records specimens with the mandible yellow basally, and I have seen one which was nearly half yellow. In the most variable character, the tail pattern, it will be apparent that there is a gradual transition northward from *berlepschi*, with no dusky subterminal bar, to *roberti* in which the dark subterminal bar occupies the whole feather except the tip. The new form is a very distinct connecting link.

The recognition of the genus *Phaeochroa* is also a matter of opinion. The bill characters are minute, but the tail is relatively as well as absolutely longer than in *Aphantochroa*. This at least is a more definite basis of separation than is available in genera like *Amazilis, Saucerrottea, Hylocharis, Basilinna, Sapphironia*, etc.

FLORISUGA MELLIVORA MELLIVORA (Linnaeus)

Permé, 6 ♂, 1 ♀; Obaldia, 1 ♂, 1 ♀.

POLYERATA AMABILIS (Gould)

Permé, 3 ♂, 3 ♀; Obaldia, 5 ♂, 4 ♀.

LEPIDOPYGA CAERULEOGULARIS CONFINIS subsp. nov.

Type.— No. 155,316, Museum of Comparative Zoölogy; ♂ ad.; Permé, Caribbean slope of eastern Panama; November 21, 1929; H. Wedel, No. 1,974.

Characters.— Resembling typical *caeruleogularis* (Gould) of western Panama, but crown (sometimes upperparts) and median rectrices greener, far less bronzy, the latter with the ends often extensively purplish black; chin and throat glittering violet purple, the blue portion confined to a narrow transitional area on the breast; resembling the north Colombian and Santa Marta races in the color of the tail feathers, but differing from them also in the color of the throat; females separable from *caeruleogularis* on the tail feather character, but not distinguishable from the Santa Marta forms. Twenty-eight specimens.

The general confusion in nomenclature which has reigned in this group for two decades is largely due to Simon, who ignored or overlooked critical comments of earlier workers like Gould and Elliott, who were entirely correct and knew just what they were talking about. A brief historical résumé is in order.

1850 Gould describes *Trochilus caeruleogularis* from David, Chiriqui.

1851 Bourcier describes *Trochilus duchassaingi* in a paper devoted to Ecuador species, but the type is said to come from "les bois entre la Gorgone et Panama," a locality which is really meaningless. The description is very brief, and is barely recognizable.

1856 (not 1853 as stated by Ridgway). The zealous Bourcier describes *Thalucrania* (sic) *coelina* from Santa Marta, a *blue*-throated species, which he compares with *duchassaingi*. The greener, less bronzy median rectrices with their purplish black tips is the chief character claimed. Bourcier was entirely correct, and Santa Marta specimens have this character.

1860 Gould shows that the type of *duchassaingi* is a young male of *caeruleogularis*, and does not recognize *coelina* as specifically distinct. In both points he is entirely correct (cf. Monog. Troch., **5**, p. 346).

1862 Lawrence describes *luminosa*, based on a *green*-throated bird from Barranquilla. It is specifically distinct from the blue-throated *caeruleogularis-coelina* section, and the two species occur together in the Santa Marta region. The type is in New York.

1871 Wyatt records "*caeruleogularis*" from Cienaga, Santa Marta, following Gould. His birds are really *caeruleogularis coelina* (Bourcier) and not *lilliae* Stone (cf. Ibis, p. 378).

1879 Elliot (Synop. Troch., p. 238) confirms Gould and recognizes *luminosa*. The type of *duchassaingi* had passed into Elliot's collection, and is now in New York.

1909 Simon (Rev. Franc. d'Orn., p. 66) reaches the remarkable conclusion that Bourcier's blue-throated *coelina* is really Lawrence's green-throated *luminosa*. This idea was apparently due to the fact that the type of *coelina* was ex-Verreaux and a duplicate from the old Verreaux collection, which Simon obtained years later, was a green-throated bird. At this time only four green-throated birds were known to exist, and Wyatt's was the only record of a blue-throated bird from Santa Marta (except for the type of *coelina*), a reference which Simon overlooked.

1917 Stone describes *lilliae*, based on two birds with the entire underparts glittering blue, from Punto Caiman at the northwestern edge of the Cienaga.

1922 Todd (Birds Santa Marta, p. 260) corrects Simon's error.

1930 Darlington rediscovers Bourcier's *coelina* at Rio Frio on the *eastern* side of the Cienaga. He follows Simon, and records these birds as *caeruleogularis duchassaingi* (cf. Bull. Mus. Comp. Zoöl., **71**, No. 5, 1931, p. 394).

The following synopsis of the species is presented.

A. Bronzier green above, particularly crown; median rectrices wholly bronzy green — *L. caeruleogularis* (Gould).

B. Darker green above; median rectrices not bronzy, always with purplish black tips.

a. Entire underparts glittering blue — *L. caeruleogularis lilliae.*

b. Abdomen green in sharp contrast to throat.

1. Chin and throat glittering blue — *L. caeruleogularis coelina.*

2. Chin and throat glittering violet — *L. caeruleogularis confinis.*

Damophila panamensis Berlepsch

Permé, 1 ♂; Obaldia, 2 ♂, 1 ♀.

A Review of Thalurania colombica (Bourcier)

Very large series are now available from every part of the range of the species, and for the first time it is possible to compare specimens from every geographic area simultaneously. Berlioz's recent sugges-

tions are fully confirmed. Not only are species like *fannyi* and *colombica* shown to intergrade completely, but the amount of local variation has naturally increased, as series have become available from more local areas. In this respect Dr. Berlioz was handicapped in having chiefly Bogotá trade skins without definite localities (cf. Bull. Mus. d'Hist. Nat., ser. 2, **2**, 1930, pp. 65–69).

In making comparisons care must be exercised in using only fully adult males. Younger males, even those with most of the glittering plaque and throat developed, are greener, less blue above, or bluer, less violet. The interscapular patch is more broken or less developed, and not only is the forking of the tail less developed, but the tail is shorter.

Thalurania colombica colombica (Bourcier)

Type locality.— "Colombia"; I suggest San Agustin, Magdalena Valley.

Range.— Chiefly Subtropical Zone, upper Magdalena Valley, the source of most "Bogotá" skins, and the Santa Marta region.

Diagnosis.— Adult male: crown glittering violet-blue; occiput and nape strongly bronzy green; upperparts strongly bluish green, bluest on the interscapular tract; the violet scapular patches at most brokenly connected across the back; wing 53–57; tail 35–45.5; fork 14–16. Female: whitish below, abdomen and flanks light gray, the flanks not extensively green; median rectrices green, steel blue terminally; forepart of wing bluish green. Large series. Tails of Bogotá specimens average 41.5, about 3 mm. longer than Santa Marta series.

Thalurania colombica insulicola subsp. nov.

Type.— No. 106,824, Museum of Comparatize Zoölogy; ♂ ad.; San Miguel, Pearl Islands, Bay of Panama; February 28, 1899; W. W. Brown.

Range.— Known only from El Rey Island, Pearl Islands.

Diagnosis.— Closely resembling typical *colombica* in color characters, but belly bluer, less violet; tail in fully adult specimens much shorter, the fork just as deep; wing and bill measurements at the maximum for *colombica*; wing 55–57; tail 35–36; fork 12–16, four specimens.

Thalurania colombica venusta (Gould)

Type locality.— Volcan de Chiriqui, Panama.

Range.— Humid Tropical Zone of Central America, from western Panama to eastern Nicaragua.

Diagnosis.— Nearest *colombica,* but crown plaque averaging more violet, less blue; upperparts much darker, the occiput and nape almost black, never bronzy; violet scapular patches more extensive and broadly connected across back; tail averaging very slightly shorter and culmen very slightly longer. Female with median rectrices more extensively bluish green terminally, and flanks much more extensively greenish. Large series.

I am unable to see that the tail in males is more violet or that the under tail coverts are less white, more steel blue. Series from eastern Costa Rica and eastern Nicaragua are slightly greener above, bluer and less violet on interscapulium and belly. They connect typical *venusta* of western Chiriqui and southwest Costa Rica with *townsendi* of eastern Honduras, and could easily be described by those who like to name slight intermediates. Specimens from the Rio Coco rapidly approach *townsendi,* some having bluish, others bluish green abdomens.

Thalurania colombica townsendi Ridgway

Type locality.— Segovia River, Honduras.

Range.— Eastern Guatemala to the Nicaraguan boundary.

Diagnosis.— Nearest *venusta,* but abdomen green instead of violet. Female with sides and flanks less extensively green. Seven specimens.

Thalurania colombica fannyi (Delattre and Bourcier)

Type locality.— Rio Dagua, near Buenaventura, western Colombia.

Range.— Tropical Zone, eastern Panama, both Caribbean and Pacific coasts (Permé, Obaldia, Ranchon, Rio Tuyra valley, Mt. Sapo region), and western Colombia (Atrato Valley, and Pacific slope of western Andes south at least to Buenavista).

Diagnosis.— General coloration of body dark and violet, exactly as in *venusta,* but crown plaque glittering green, instead of violet blue, almost always in fully adult specimens, with posterior feathers bluish green to blue in varying amounts individually; tail very long and fork very deep, the maximum for the species; wing 51–55; tail 42–50; fork 18–25; culmen 18–20. Female, abdomen darker, smoky gray in sharp contrast to throat. Large series.

The characters of true *fannyi,* of both color and size, were perfectly brought out by Delattre and Bourcier in their original description and are confirmed by Simon and Dalmas (Ornis, **11**, 1901, p. 221) and Hellmayr (P.Z.S., 1911, p. 1,183). The majority of skins of green-crowned *Thalurania* from western Colombia in older museums, es-

pecially "Bogotá" specimens, are not *fannyi*, but are described below. It will be noted that *fannyi* completely separates the blue-crowned races from each other. The Pearl Island Bird is a particularly remarkable, isolated relict.

THALURANIA COLOMBICA SUBTROPICALIS subsp. nov.

Type.— No. 104,142, Museum of Comparative Zoölogy; ♂ ad.; near Cali, Cauca Valley (5,000 ft.) Colombia; June, 1898; J. H. Batty.

Range.— Subtropical Zone, eastern and western slopes of the western Andes of Colombia, north to Mt. Pirri, eastern Panama.

Diagnosis.— Crown plaque as in *fannyi*; general coloration very different from *fannyi* and *venusta*, closest to typical *colombica*, but averaging less bronzy on occiput; tail very much shorter than in *fannyi*, averaging shorter than *colombica*; bill shorter and slenderer than in any other race; wing 51–53.5; tail 32–39; fork 10–15; culmen 16–18. Female easily distinguishable from *fannyi* in having a much larger and bluer scapular patch. Good series.

A distinct and well characterized form, which has usually been referred to *verticeps* Gould. Specimens from Mt. Pirri have longer bills, like *fannyi*, and are not typical. Series from the Pacific slope of the western Andes have shorter tails than those from the eastern slope, which are not shorter than *colombica*.

THALURANIA COLOMBICA VERTICEPS Gould

Type locality.— "Quito," Ecuador.

Range.— Known from "Quito" trade skins, and with absolute definiteness only from Nanegal and Intac.

Diagnosis.— Nearest *subtropicalis* but upperparts uniform green, without a bluish tinge, abdomen bluer, less violet, and blue posterior border of plaque almost always absent; tail relatively short as in *colombica*, and bill longer and stouter than in *subtropicalis*, again resembling *colombica*. Female lacking the blue scapular patch of *subtropicalis*.

THALURANIA COLOMBICA FANNYI (Delattre and Bourcier)

Permé, 11 ♂, 5 ♀; Obaldia, 16 ♂, 5 ♀; Ranchon, 1 ♀.

CHALYBURA UROCHRYSA INCOGNITA Griscom

Permé, 18 ♂, 4 ♀; Obaldia, 2 ♂.

This is the finest series in the world of a comparatively little known Hummingbird, which connects the Colombian *urochrysa* with the rare *isaurae* of western Panama.

Heliothryx barroti (Bourcier and Mulsant)

Permé, 2 ♂, 1 ♀; Obaldia, 1 ♂.

Anthoscenus longirostris stuartae (Lawrence)

Obaldia, 1 ♀.

The characters of this well marked form were pointed out by Chapman (Birds Colombia, p. 311) and more recently by Simon. It is new to Panama. Birds from the Canal Zone westward and northward must be known as *veraguensis* (Boucard), based on a freak, and *chalcura* Simon is a synonym.

TROGONIDAE

Trogon curucui tenellus Cabanis

Permé, 3 ♂, 2 ♀; Obaldia, 2 ♂, 1 ♀; Ranchon, 2 ♂.

This series shows no approach to *cupreicauda* Chapman of western Colombia.

Trogon violaceus caligatus Gould

Permé, 1 ♂.

A typical example of this well marked race, not previously recorded from Panama. I here follow the nomenclatural changes recently proposed by my colleague, J. L. Peters. This form was previously known as *caligatus columbianus* Chapman.

Trogon strigilatus chionurus Sclater and Salvin

Obaldia, 1 ♂, 3 ♀; Permé, 6 ♂, 3 ♀; Ranchon, 1 ♂, 1 ♀.

Curucujus melanurus macrourus (Gould)

Permé, 3 ♂.

Curucujus massena massena (Gould)

Permé, 3 ♂, 5 ♀; Obaldia, 2 ♂, 2 ♀; Ranchon, 1 ♀.

ALCEDINIDAE

Megaceryle torquata torquata (Linnaeus)

Permé, 2 ♀, 1 ?; Obaldia, 1 ♀.

Megaceryle alcyon alcyon (Linnaeus)

Permé, 1 ♀, Nov. 11, 1929; Obaldia, 1 ♀, Nov. 26.

Chloroceryle amazona (Latham)

Permé, 1 ♂, 1 ♀.

Chloroceryle americana isthmica (Goldman)

Permé, 2 ♂, 1 ♀; Obaldia, 1 ♂, 2 ♀, 1 ?; Ranchon, 1 ♂.

Chloroceryle inda (Linnaeus)

Permé, 4 ♂, 1 ♀.

MOMOTIDAE

Baryphthengus martii semirufus (Sclater)

Permé, 6 ♂, 1 ♀; Obaldia, 1 ♂, 1 ♀.

Momotus subrufescens reconditus Nelson

Permé, 2 ♂, 1 ♀.

These specimens again prove how close a correlation exists between darkness of coloration and humidity of environment in this group. They are as dark as the darkest extreme in our series of *reconditus*.

Electron platyrhynchum minor (Hartert)

Permé, 4 ♂, 1 ♀.

While these specimens are not, of course, topotypes of *suboles* Nelson from Cana on the opposite side of the mountains, they show none of the characters claimed for that race, which is not recognizable.

Hylomanes momotula obscurus Nelson

Obaldia, 1 ?.

GALBULIDAE

Jacamerops aurea penardi Bangs and Barbour

Obaldia, 1 ♂, 1 ♀.

BUCCONIDAE

Notharcus hyperrhynchus hyperrhynchus (Sclater)

Permé, 5 ♂, 3 ♀.

I follow Chapman (Birds Ecuador, p. 354), who regards *leucocrissus* Sclater as a synonym of *hyperrhynchus*. I think *dysoni* a very slight form, separable on its larger bill, and doubt the validity of any of its color characters.

Notharchus tectus subtectus (Sclater)

Obaldia, 5 ♂, 2 ♀.

Nystalus radiatus (Sclater)

Permé, 1 ♀; Obaldia, 3 ♂, 3 ♀.

Malacoptila panamensis panamensis Lafresnaye

Permé, 3 ♀; Obaldia, 1 ♂, 3 ♀.

CAPITONIDAE

Capito maculicoronatus melas subsp. nov.

Type.— No. 155,380, Museum of Comparative Zoölogy; ♂ ad.; Puerto Obaldia, Caribbean slope of Darien, eastern Panama; August 8, 1930.

Characters.— Differing from the three described races in the bill being mostly black, the horn color confined to the posterior part of the culmen and a spot on the maxilla; flanks also more heavily flammulated and spotted with black; size, bill structure and red flank patches as in *pirrensis* Nelson, but pectoral band of males broader; crown spots white as in *pirrensis,* but less extensive and not coalesced as in *maculicoronatus*; wing of females 75.5–80; 7 ♂, 7 ♀, and adequate representation of the three other forms.

A surprisingly variable species in narrow limits. The dark bill is obvious at a glance, though the other color characters would be sufficient in themselves for formal description.

RAMPHASTIDAE

Ramphastos sulphuratus brevicarinatus Gould

Permé, 1 ♂, 2 ♀.

Ramphastos swainsoni Gould

Permé, 1 ♂.

Pteroglossus torquatus torquatus (Gmelin)

Permé, 4 ♂, 1 ♀.

These show no approach to the rather inconstant *nuchalis*.

Selenidera spectabilis Cassin

Obaldia, 2 ♂, 3 ♀.

PICIDAE

Centurus pucherani pucherani (Malherbe)

Permé, 5 ♂, 4 ♀; Obaldia, 5 ♂, 2 ♀.

Veniliornis kirkii cecilii (Malherbe)

Permé, 2 ♂; Obaldia, 2 ♂, 7 ♀.

Celeus loricatus mentalis Cassin

Permé, 2 ♂, 6 ♀; Obaldia, 4 ♂, 5 ♀.

Phloeoceastes melanoleucus malherbii (Gray)

Permé, 2 ♀; Obaldia, 4 ♂.

Phloeoceastes haematogaster splendens (Hargitt)

Obaldia, 1 ♂.

FORMICARIIDAE

Cymbilaimus lineatus fasciatus (Ridgway)

Obaldia, 1 ?.

Taraba major transandeanus (Sclater)

Permé, 4 ♂, 4 ♀.

Thamnophilus punctatus atrinucha Salvin and Godman

Permé, 4 ♂, 1 ♀; Obaldia, 1 ♂; Ranchon, 1 ♂.

Thamnistes anabatinus coronatus Nelson

Permé, 1 ♂, 1 ♀.

Xenornis setifrons Chapman

Permé, 1 ♂; Obaldia, 1 ♂.

This remarkable and peculiar Ant bird has so far been known only from the type from Tacarcuna. The female has yet to be discovered. The genus will probably be found in time throughout the Colombian-Pacific fauna.

Dysithamnus puncticeps puncticeps Salvin

Obaldia, 2 ♂, 1 ♀.

For many years this Ant Wren has been sufficiently rare in collections to make it impossible to assemble adequately balanced and representative series from all parts of its range. Until very recently topotypes did not exist in America, and specimens from eastern Panama were assumed to be typical *puncticeps*. The combined collections in Cambridge and New York lead, however, to interesting conclusions, which are worth putting on record. The species was originally based on specimens sent to Salvin by Arcé, labeled Santiago de Veraguas, western Panama. As I have several times had occasion to show, Arcé often used Santiago as a general and not a specific locality, and some of his birds came from the Caribbean slope of Veraguas at the terminus of the old Calovevora trail. This Ant Wren is one of these cases. It is everywhere a humid rain forest bird, and cannot conceivably occur in the dry savannas around Santiago. Benson was particu-

larly on the lookout for it while collecting for me in every section of Veraguas, and never found it until he reached the Caribbean lowlands, where he secured a large series. These specimens can consequently be regarded with confidence as satisfactory topotypical material. Eastern Panama specimens in New York and Cambridge, hitherto referred to *puncticeps*, prove to be another race. Another poorly known bird is *Dysithamnus striaticeps* Lawrence of eastern Costa Rica. Its crown is streaked with black, rather than spotted with black and white, and it appears quite distinct, but this character is more or less repeated in the Ecuador race *flemmingi*. We now know that intergradation between Costa Rica and west Panama races is very abrupt, and must be between the Rio Sixaola and the Almirante region. The fact, therefore, that Ridgway saw single specimens from the Rio Sixaola and Rio Pacuare which he referred to *puncticeps*, while others were *striaticeps*, is not to my mind conclusive evidence of their specific distinctness. It is just in this area that both types would be expected. The following synopsis of the species is presented.

1. *Dysithamnus puncticeps striaticeps* Lawrence, 1867, from Angostura, eastern Costa Rica. General coloration as in typical *puncticeps*, but male with no white spots on pileum; upperparts and flanks averaging more olive brown, less gray; chest with more gray, less white, more broadly streaked with dusky; female with pileum more tawny, less ochraceous, the black streaked with dusky; tail shorter. Caribbean lowlands of eastern Nicaragua and eastern Costa Rica, common northward, but rare in central and southeastern Costa Rica.

2. *Dysithamnus puncticeps puncticeps* Salvin, 1866, Santiago de Veraguas, in Panama = Caribbean lowlands. Palest and grayest race; male with pileum spotted with white; upperparts olive-gray; flanks with little or no olive-brown wash; more white below, with fewer and finer dusky streaks; female with pileum more ochraceous, less tawny, with distinct blackish blotches; tail shorter. Caribbean lowlands of Panama (Almirante, Rio Calovevora, Barro Colorado Island and Obaldia in extreme eastern Darien), and adjacent parts of west central Colombia.

3. DYSITHAMNUS PUNCTICEPS INTENSUS, subsp. nov.

Type.— No. 87,219, Museum of Comparative Zoölogy; ♀ ad.; Mt. Sapo, Pacific slope of Darien, eastern Panama; April 23, 1922; Barbour and Brooks.

Characters.— Resembling typical *puncticeps*, but darker and more richly colored; male distinctly more olive-brown, less gray, on rump,

tail and primary edgings, strongly olive brown on the flanks; even more narrowly streaked with dusky below; female with pileum even darker tawny than *striaticeps,* but heavily streaked with black, rather than blotched as in *puncticeps*; general coloration both above and below darker and richer, sometimes tawny on upper tail coverts and wing edgings, the underparts almost uniform rich buff or ochraceous more faintly streaked; tail longer. Pacific slope of eastern Darien and western Colombia.

4. *Dysithamnus puncticeps flemmingi* Hartert, 1900, Rio Verde, northwest Ecuador. Male, pileum without white spots as in *striaticeps,* but streaked as in *intensus*; coloration otherwise as in *intensus*; female, general coloration nearer *puncticeps* than *intensus,* the streaking below barely apparent, and the spots on wing coverts smaller; tail longer. Pacific slope of southwest Colombia and northwest Ecuador.

Material examined

striaticeps.— Eastern Nicaragua,[1] 13; eastern Costa Rica, 51.

puncticeps.— Western Panama, Boquete Trail back of Almirante, 1 ♂; Rio Calovevora,[1] 10 ♂, 9 ♀; eastern Panama, Obaldia, 2 ♂, 1 ♀ (with longer tails as in the two southern races); Colombia,[1] Alto Bonito, 6; La Vieja, 1; Puerto Valdivia, 1. The Colombian specimens are nontypical, but nearer *puncticeps* than *intensus.*

intensus.— Eastern Panama, Pacific slope, Mt. Sapo, 1 ♂, 3 ♀; Cituro,[1] Cupé River,[1] 1 ♂, 1 ♀; western Colombia,[1] Baudo, 1; Novita, 1.

flemmingi.[1]— Northwest Ecuador, 1; southwestern Colombia, Barbacoas, 6.

Myrmotherula surinamensis pacifica Hellmayr

Permé, 1 ♂.

Myrmotherula fulviventris fulviventris Lawrence

Permé, 5 ♂, 1 ♀; Obaldia, 7 ♂, 6 ♀; Ranchon, 1 ♂.

Myrmotherula axillaris albigula Lawrence

Permé, 2 ♂, 2 ♀; Obaldia, 2 ♂, 2 ♀; Ranchon, 1 ♂, 1 ♀.

Microrhopias boucardi consobrina (Sclater)

Permé, 1 ♀; Obaldia, 1 ♂.

[1] All in American Museum of Natural History.

MYRMECIZA LAEMOSTICTA PALLIATA Todd

Permé, 1 ♂, 1 ♀; Obaldia, 3 ♂, 3 ♀; Ranchon, 1 ♀.

MYRMECIZA EXSUL EXSUL Sclater

Permé, 3 ♂, 3 ♀; Ranchon, 1 ♂.

It is interesting to find that *exsul* practically reaches Colombia on the Caribbean side of Darien, and is not replaced by *maculifer cassini*, the case on the Pacific side.

FORMICARIUS ANALIS PANAMENSIS Ridgway

Permé, 14 ♂, 1 ♀, 1 ?; Obaldia, 2 ♂; Ranchon, 2 ♂.

GYMNOPITHYS BICOLOR BICOLOR (Lawrence)

Permé, 8 ♂, 5 ♀, 2 ?; Obaldia, 3 ♂; Ranchon, 1 ♂, 1 ♀.

HYLOPHYLAX NAEVIOIDES NAEVIOIDES (Lafresnaye)

Permé, 9 ♂, 7 ♀.

The males show a decided approach to *subsimilis* Todd in having grayer crowns and tails and less buffy wash on flanks and vent than typical *naevioides*. Females do not differ, however, and the series as a whole should certainly be referred to the typical form.

PHAENOSTICTUS MCLEANNANI CHOCOANUS Bangs and Barbour

Permé, 9 ♂, 7 ♀, 2 ?; Obaldia, 4 ♂; Ranchon, 1 ♂.

One of the finest series of this race in existence. The birds show all the diagnostic characters of *chocoanus* above, but resemble the typical form in having darker and more richly colored underparts.

MYRMORNIS STICTOPTERA (Salvin)

Permé, 2 ♂, 2 ♀; Obaldia, 2 ♂, 1 ♀; Ranchon, 1 ♀.

PITTASOMA MICHLERI MICHLERI Cassin

Permé, 9 ♂, 5 ♀; Obaldia, 1 ♂.

HYLOPEZUS PERSPICILLATUS PERSPICILLATUS (Lawrence)

Permé, 6 ♂, 2 ?; Obaldia, 1 ♂.

FURNARIIDAE

Automolus pallidigularis pallidigularis (Lawrence)

Permé, 7 ♂, 4 ♀, 1 ?; Obaldia, 1 ♂, 1 ♀; Ranchon, 3 ♂, 1 ?.

Hyloctistes subulatus assimilis (Berlepsch and Taczanowski)

Ranchon, 1 ♀.

Philydor fuscipennis erythronotus Sclater and Salvin

Obaldia, 1 ♂, 1 ♀: Ranchon, 1 ♂, 1 ♀.

Xenops minutus littoralis Sclater

Permé, 2 ♂, 1 ♀.

Sclerurus mexicanus andinus Chapman

Permé, 2 ♂; Obaldia, 2 ♂; Ranchon, 1 ♂.

In discussing this species, ornithologists are handicapped by its rarity, and it is as yet out of the question to assemble even fair series from all the type localities of the numerous described forms. The bird is extremely variable, but it remains to be determined how much is racial and how much can be shown to be individual. Hellmayr in his recent monographic catalogue recognizes all the proposed races, while Chapman (Birds Ecuador, 1927, p. 453) suggests referring all birds from Bolivia to eastern Panama under one name.

The specimens listed above do not assist us in a better understanding of the species in Central America. Typical *mexicanus* is a large and long billed extreme, more rusty than olive above and of medium darkness. The type series of *pullus* is a very dark extreme. Canal Zone specimens are *mexicanus* in color, but are radically smaller. The west Ecuador *obscurior* Hartert seems distinct on the basis of the characters given by Hellmayr. The four specimens from the Caribbean side of Darien are small like *anomalus* but tend to be more olive, less rusty. They consequently approximate the characters of *andinus* Chapman of the eastern and central Andes of Colombia, which Chapman no longer maintains, but Hellmayr restores. One of the type series of *andinus* before me is much *darker*, however, than any of eight Panama specimens, and in view of Chapman's comments, it is apparent that

audinus and *anomalus* are inseparable. It is possible that east Panama and Colombian specimens combined may prove separable from the west Ecuador *obscurior*, provided that we remember that darker or lighter, rustier or more olive, coloration is apparently individual in this whole area, and is constant only in western Panama, where *pullus* is distinct.

Sclerurus guatemalensis guatemalensis (Hartlaub)

Permé, 4 ♂, 1 ♀, 1 imm.; Obaldia, 1 ♂; Ranchon, 3 ♂, 1 ♀.

This series differs at a glance from specimens from Guatemala, British Honduras and eastern Costa Rica in having the chest less extensively tawny, much less contrasted with the breast, and the upperparts raw umber to sepia instead of rich dark vandyke brown; in other words less rusty, more olive brown. The wing of northern birds measures 87–92, of Permé birds, 84–87. Series from southwestern Costa Rica are as large as northern birds and like them in color, but average less tawny on the chest. Canal Zone (Caribbean slope) specimens are like eastern Costa Rican specimens but smaller. Darien (Pacific slope) series are intermediate, perhaps a trifle nearer the Permé specimens in both color and size.

I would describe the Permé series were I not suspicious of post mortem change in color. It so happens that all the northern material was collected twenty-five or thirty years ago, and this may account for their rustier tone throughout. The size differences are too trifling to characterize a subspecies by themselves. I prefer, therefore, to await fresh material from northern Central America.

DENDROCOLAPTIDAE

Glyphorhynchus spirurus sublestus Peters

Permé, 5 ♂, 3 ♀, 1 ?; Obaldia, 2 ♂, 1 ?.

I agree with Hellmayr and Peters that there is a slight average difference between *pectoralis* of northern Central America and very large series from Costa Rica southward.

Dendrocincla meruloides ridgwayi Oberholser

Permé, 1 ♂; Obaldia, 1 ♀.

Having now seen the type series of *christiani* Bangs and Penard and the excellent series of *ridgwayi* in the Museum of Comparative

Zoölogy, as well as the material in New York, I thoroughly agree with Dr. Chapman (Birds Ecuador, pp. 458–460) that *christiani* is inseparable.

Xiphorhynchus guttatus nanus (Lawrence)

Permé, 8 ♂, 5 ♀; Obaldia, 4 ♂, 4 ♀.

Xiphorhynchus erythropygius insolitus (Ridgway)

Permé, 1 ♀.

Some confusion as to the validity of *insolitus* has arisen, due to an error in the type locality (cf. Hellmayr, Birds Americas, pt. 4, p. 309, footnote). The type locality is "Cascajal, Coclé, eastern Panama." It so happens that Coclé is a department of *western* Panama, and is exclusively an arid tropical savannah country in which the rain forest species, which predominated in this lot of birds, do not occur. There is a Rio Cascajal in Colon just east of the Canal Zone, and a Rio Coclé just west of the zone, both on the Caribbean slope of course. There is no Cascajal in Coclé, so the collection was probably made at one of the two points suggested above. Faunally it makes no difference which, and the facts are that specimens from eastern Panama agree with the type. It is not surprising, therefore, that Dr. Hellmayr wondered what *insolitus* might be, as specimens from Veraguas are *punctigulus*, just as he says. Were it not for *insolitus* which occurs in eastern Panama and extreme northwestern Colombia, *punctigulus* could scarcely be kept distinct from *aequatorialis*, so slight are its characters.

Xiphorhynchus lachrymosus lachrymosus (Lawrence)

Permé, 6 ♂, 1 ♀; Obaldia, 3 ♂, 3 ♀; Ranchon, 1 ♂.

Campylorhamphus trochilirostris brevipennis subsp. nov.

Type.— No. 107,335, Museum of Comparative Zoölogy; ♂ ad.; Lion Hill, Canal Zone, Panama; March 7, 1900; W. W. Brown.

Characters.— Nearest *C. t. venezuelensis* Chapman, and not differing constantly in coloration, but wing and tail very much shorter, the bill, however, as long as *venezuelensis*, and consequently proportionately longer.

Measurements of wing

venezuelensis 5 ♂ (northern Venezuela [1] and Santa Marta) 102–106; 2 ♀, 96.

brevipennis 5 ♂ (Canal Zone and Permé) 92–96.5; 3 ♀, 88–90.

Remarks.— Ridgway's few specimens brought out the abruptly smaller size of Panama birds, and he suggested that they might prove separable. He had, however, but one female from Venezuela and no Colombian specimens at all. Hellmayr, on the other hand, had no Panama specimens available in his recent monographic treatment of the family.

Lepidocolaptes souleyetii lineaticeps (Lafresnaye)

Permé, 2 ♂; Obaldia, 1 ♀.

Dendrocolaptes certhia sancti-thomae (Lafresnaye)

Permé, 4 ♂, 1 ♀, 1 ?; Obaldia, 1 ?.

TYRANNIDAE

Colonia colonus leuconota (Lafresnaye)

Permé, 1 ♀; Obaldia, 1 ♂.

Tyrannus tyrannus (Linnaeus)

Permé, 1 ♂, 4 ♀; Obaldia, 3 ♀.

The Kingbird proves to be a common migrant: March 31 to May 9; October 4 to November 8.

Tyrannus melancholicus chloronotus Berlepsch

Permé, 1 ♂, 1 ♀; Obaldia, 1 ♀.

Tyrannus dominicensis dominicensis (Gmelin)

Permé, 1 ♂, 1 ?; Obaldia, 1 ♀.

Sirystes albocinereus albogriseus (Lawrence)

Ranchon, 1 ♀.

One of the rarest of Panama birds.

[1] Includes cotypes.

Myiodynastes luteiventris Sclater

Obaldia, 1 ♂ (Nov. 20, 1930).

A transient in Panama, for which there are few records.

Myiodynastes maculatus nobilis Sclater

Permé, 7 ♂, 1 ♀, 1 ?; Obaldia, 4 ♂, 2 ♀.

I agree with Todd (Birds Santa Marta, 1922, p. 344) that *nobilis* is inseparable from *maculatus*, but defer to Hellmayr's opinion who recognizes the subspecies.

Megarhynchus pitangua pitangua (Linnaeus)

Obaldia, 1 ♂.

The boat-billed Flycatcher has never been recorded between the Pacific side of the Canal Zone and the Magdalena Valley in Colombia. As might be expected, the present specimen is intermediate between *pitangua* and *mexicanus*, but on the whole is slightly nearer the former.

Myiozetetes cayannensis harterti Bangs and Penard

Permé, 3 ♂, 4 ♀.

Myiozetetes granadensis granadensis Lawrence

Permé, 1 ♂.

Myiarchus crinitus (Linnaeus)

Permé, 1 ♀, 1 ? (March 2, 5); Obaldia, 1 ♀ (Oct. 6).

Myiarchus ferox panamensis Lawrence

Permé, 1 ♂.

Myiarchus tuberculifer brunneiceps Lawrence

Permé, 2 ♀, 2 ?; Obaldia, 3 ♂, 1 ♀, 2 ?.

One or two of the freshest specimens have the pileum black, thus approaching *nigriceps*.

Nuttallornis mesoleucus mesoleucus (Lichtenstein)

Permé, 1 ♀, May 19, 1929.

MYIOCHANES VIRENS (Linnaeus)

Obaldia, 1 ♂, 1 ♀, April 29 and May 1.

MYIOCHANES RICHARDSONII RICHARDSONII (Swainson)

Permé, 1 ♂, 1 ♀; Obaldia, 1 ♀; Nov. 1–21.

TERENOTRICCUS ERYTHRURUS FULVIGULARIS (Salvin and Godman)

Permé, 1 ♂; Obaldia, 4 ♂.

Eleven specimens in all from eastern Panama are distinctly duller colored below than a large series from Central America, and the frontal band is less ochraceous, less contrasted with the pileum. No birds are available from Colombia or west Ecuador, and it remains to be determined whether these slight differences are constant within a definite geographic range.

MYIOBIUS SULPHUREIPYGIUS AUREATUS Bangs

Permé, 2 ♂, 2 ?; Obaldia, 1 ♂, 2 ♀, 1 ?.

ONYCHORHYNCHUS MEXICANUS FRATERCULUS Bangs

Obaldia, 1 ♀; Ranchon, 1 ♀.

PLATYRINCHUS CORONATUS SUPERCILIARIS Lawrence

Permé, 1 ♀; Obaldia, 5 ♂, 3 ♀, 2 ?.

CNIPODECTES SUBBRUNNEUS SUBBRUNNEUS (Sclater)

Ranchon, 1 ♂.

TOLMOMYIAS FLAVOTECTUS Hartert

Permé, 2 ♂, 1 ♀; Obaldia, 1 ♂; Ranchon, 1 ♂.

RHYNCHOCYCLUS OLIVACEUS BARDUS (Bangs and Barbour)

Permé, 3 ♂, 4 ♀, 1 ?; Obaldia, 2 ♂, 7 ♀; Ranchon, 1 ♂.

This fine series contains both worn and fresh specimens, and leads to some interesting discoveries. A series from Cana, Darien was recently (Bull. Mus. Comp. Zoöl., **69**, No. 8, 1909, p. 173) recorded by me erroneously as *bardus*. An April specimen was unquestionably *bardus*, and 6 July and August birds were much darker, but these

differences were thought to be perhaps due to season and wear. This proves not to be the case, and the Cana series contains two distinct species, one of which is *R. olivaceus bardus*, and the other approaches *brevirostris pacificus* Chapman of Central America. Hellmayr's arrangement in the Catalogue of Birds of the Americas, pt. 5, is consequently endorsed by the discovery that the two supposed species occur together at Cana, and the specimen in the American Museum from Mt. Tacarcuna, commented upon by Hellmayr, is unquestionably the same as the Cana series before me. These birds connect *brevirostris* with *pacificus*, and may be described as

Rhynchocyclus brevirostris hellmayri subsp. nov.

Type.— No. 140,732, Museum of Comparative Zoölogy; ♂ ad.; Cana, Pacific slope of Darien, Panama; August 6, 1928; Rex R. Benson.

Characters.— Connecting *brevirostris* (Cabanis) of Central America with *pacificus* (Chapman) of western Colombia; differing from the latter in the green being less oily yellow, particularly on throat and chest; the chin usually grayish green contrasted with the throat; edgings to wing coverts and secondaries yellow with little or no tawny tinge; differing from *brevirostris* in being a darker oilier green throughout below, the chest much more contrasted with the abdomen; yellow of abdominal area more restricted; chin never as purely gray; edgings to wing coverts and secondaries much yellower, less green; bill slightly longer and wider, at nostrils 10–11 mm., versus 8–9 mm.

brevirostris.— Thirty-two specimens, Mexico to western Panama.

hellmayri.— Cana, Darien, 2 ♂, 4 ♀.

pacificus.— West Ecuador, Paramba, 1 ♂; Pambilar, 1 ♀.

I might add here that a marked specific character between *brevirostris* and *olivaceus* is the lighter undersurface of the tail in the latter, and the inner webs of the tail feathers always have conspicuously paler edgings. In *brevirostris* these edgings are lacking or barely perceptible.

Todirostrum cinereum finitimum Bangs

Obaldia, 1 ♂ juv., 1 ♀, 1 ?.

Perissotriccus atricapillus (Lawrence)

Permé, 2 ?; Obaldia, 1 ♂, 1 imm.

The second record for Panama of this rare little Tody-Flycatcher. The immature show variations which are like those of *Todirostrum*. The bill is shorter, and the pileum is much paler.

ELAINEA GAIMARDII MACILVAINII Lawrence

Permé, 2 ♂.

It is only in the last few years that this species has been detected in Panama east of the Canal Zone.

CAMPTOSTOMA PUSILLUM FLAVIVENTRE Sclater and Salvin

Permé, 1 ?; Obaldia, 2 ?.

It is somewhat unexpected to find *flaviventre* so near the Colombian boundary, when *pusillum* is reported for the whole of Tropical Colombia, including the Atrato River. My three specimens show all the characters of *flaviventre* to an extreme degree; in fact, they are a deeper and brighter yellow than any in a series from Panama City to Costa Rica. They are, however, freshly moulted late summer and fall specimens, and the color differences are presumably seasonal and have no racial significance.

Seasonal change cannot, however, account for the differences shown by an excellent series from the Pearl Islands. They were all taken in spring, and about half are quite worn and consequently grayer, less greenish above. But if the unworn specimens be compared with similar unworn specimens from the mainland, slight but constant color characters are established. There is also a well marked size difference, so I propose

CAMPTOSTOMA PUSILLUM MAJOR subsp. nov.

Type.— No. 104,878, Museum of Comparative Zoölogy; ♂ ad.; San Miguel, El Rey Island, Pearl Islands, Bay of Panama; May 4, 1900; W. W. Brown.

Characters.— Averaging slightly grayer, less olive above, with the cap slightly paler and less contrasted; considerably larger; wing of males 52.5–56.5 (54.3), instead of 48–52 (50.8). Fifteen specimens.

Only one male (from Pacheca Island) is indistinguishable in color from the dullest comparable mainland specimen, but it is much larger.

Until the specimens listed above, *Camptostoma* was unrecorded from Darien. However, the genus has recently been found on the Pacific side of Darien also. Benson collected one at Cana in April, 1928. This specimen is unfortunately a juvenal male and is not definitely identifiable as the entire upperparts have light grayish edgings and the wing bars are buffy. The size (wing 45 mm.) is very small, and the

chin and throat are grayish in marked contrast to the breast. On the whole it is reasonably certain that this bird could not be referred to *flaviventre*. As matters stand now, the genus is unrecorded between Panama City and Cana, and is unknown on the Pacific coast of Colombia.

Microtriccus brunneicapillus brunneicapillus (Lawrence)

Permé, 1 ♀; Obaldia, 1 ♂.

Not distinguishable from Canal Zone examples.

Mionectes olivaceus hederaceus Bangs

Permé, 7 ♂, 1 ♀; Obaldia, 11 ♂, 3 ♀; Ranchon, 1 ♂, 2 ♀.

Pipromorpha oleaginea parca Bangs

Permé, 2 ♂, 1 ♀; Obaldia, 7 ♂, 2 ♀, 2 ?.

PIPRIDAE

Pipra velutina minuscula Todd

Permé, 9 ♂, 1 ♀; Obaldia, 2 ♂, 1 ♀; Ranchon, 2 ♂, 2 ♀.

Pipra erythrocephala erythrocephala (Linnaeus)

Permé, 11 ♂, 6 ♀; Obaldia, 2 ♂; Ranchon, 1 ?.

An examination of 166 specimens has recently induced Hellmayr (Cat. Birds America, pt. 6, 1929, p. 29) not to recognize *actinosa* Bangs and Barbour. The slight average characters of this form prove not to occupy a continuous geographic area, and the course recommended seems conservative and more practicable. I have already shown that series from Cana, further east than Mt. Sapo, the type locality of *actinosa*, must be referred to *erythrocephala*.

Chloropipo holochlora suffusa subsp. nov.

Type.— No. 155,715, Museum of Comparative Zoölogy; Obaldia, Caribbean slope of eastern Panama; July 31, 1930; H. Wedel.

Characters.— Resembling *litae* Hellmayr of northwestern Ecuador in being olivaceous green instead of bright grass green as in typical *holochlora*, but very much darker throughout, the belly brighter yellow

as in *holochlora*, and consequently much more contrasted with the dark olive green breast, chin distinctly lighter and grayer than throat.

Material examined

holochlora.— Eastern Ecuador, San José, 1 ♂, 1 ♀.

litae.— Northwestern Ecuador, Gualea, 2 ♀.

suffusa.— Eastern Panama, Cana, 1 ♂; Obaldia, 1 ♂; Ranchon, 1 ♂.

The Cana specimen had a very uneven make-up below, but the type sent in by Wedel shows that the Panama representative is strikingly distinct. The fourth known specimen of the genus from Panama (Rio Tuyra) is in the American Museum of Natural History, but that institution did not possess topotypical material of *litae* up to the time I left in 1927.

Corapipo altera altera Hellmayr

Permé, 5 ♂; Obaldia, 10 ♂; of which 3 are immature.

Manacus vitellinus vitellinus (Gould)

Permé, 19 ♂, 6 ♀; Obaldia, 4 ♂, 1 ♀.

It is interesting to determine that birds from the Caribbean slope of Panama are the typical form and show none of the characters of the Pacific coast *viridiventris* Griscom.

Schiffornis turdinus panamensis Hellmayr

Permé, 1 ?.

Sapayoa aenigma Hartert

Permé, 1 ♂; Obaldia, 3 ♂, 3 ♀; Ranchon, 1 ♂, 2 ♀, 1 ?.

COTINGIDAE

Cotinga nattererii (Boissoneau)

Permé, 8 ♂, 4 ♀; Obaldia, 1 ♂.

Hellmayr, in his recent monograph of the family, comments on the respects in which a single "Bogotá" specimen differs from Panama and Pacific Colombian series. I, too, have but a single "Bogotá" male, fully adult. The purple of the abdominal area is *not* lighter, but the bill is notably longer and wider than in any of sixteen other males at hand.

ATTILA SPADICEUS SCLATERI Lawrence

Permé, 3 ♂, 3 ♀; Obaldia, 2 ♂, 1 ♀.

LANIOCERA RUFESCENS (Sclater)

Permé, 1 ♀.

RHYTIPTERNA HOLERYTHRA HOLERYTHRA (Sclater and Salvin)

Obaldia, 1 ♂.

LIPAUGUS UNIRUFUS CASTANEOTINCTUS (Hartert)

Permé, 2 ♂, 1 ♀, 1 ?; Obaldia, 8 ♂, 1 ♀.

I have now examined over one hundred specimens of this Cotinga in good series from Mexico to western Colombia, and I entirely agree with Chapman and Hellmayr that the recognition of the intermediate *clarus* (Ridgway) serves no useful purpose. Freshly moulted specimens are not so dull or pale as others, and skins twenty-five to thirty years old are always duller than more recently killed material. This is the chief reason why the Costa Rican series in the eastern museums, mostly killed from 1898–1906, are duller and paler than the fresher material which has been reaching the same museums from eastern Panama in recent years.

PACHYRHAMPHUS CINNAMOMEUS CINNAMOMEUS Lawrence

Permé, 1 ♂, 1 ♀; Obaldia, 3 ♂, 1 ♀.

I have examined large series of this species, but not until I came to Cambridge did I ever see a good series from northern Central America, as north of eastern Nicaragua *P. cinnamomeus* rapidly becomes uncommon to rare. The situation is one which is all too common among the more widely distributed Central American birds. We have a pale extreme *magdalenae* Chapman in northern Colombia and a very richly colored extreme in northern Central America, and the ideal taxonomy would be to supply these extremes with names. It so happens, however, that the Canal Zone is the type locality, and large series from Panama are intermediate between the two extremes mentioned above, although on the whole nearer *magdalenae*, with the type of which I am familiar, as well as Santa Martan specimens. There is no recourse but to describe a slight but distinctly characterized northern form.

Pachyrhamphus cinnamomeus fulvidior subsp. nov.

Type.— No. 119,889, Museum of Comparative Zoölogy; ♀ ad.; Toledo district, British Honduras; October 22, 1906; Morton E. Peck.

Characters.— Resembling typical *cinnamomeus* Lawrence, but wing averaging 4–5 mm. longer, and color of underparts much richer, deeper buff in worn plumage, rich tawny in fresh specimens; averaging slightly darker above.

Specimens examined

cinnamomeus.— Canal Zone, 9; Darien, 21; western Panama, 12.

fulvidior.— Guatemala, 1; British Honduras, 7; Honduras, 1; Costa Rica, 9.

Remarks.— The appreciation of the characters of the new subspecies depends absolutely upon the possession of comparable material. Worn specimens of this species are always much paler below than fresh, which are consequently always more richly colored relatively. Fortunately the splendid series listed above contains both fresh and worn specimens from each geographic area. Roughly speaking *worn* specimens of *fulvidior* are not distinguishable from *fresh* Canal Zone specimens, but are more richly colored below than equally worn specimens from Panama. Similarly fresh birds from British Honduras are separable at a glance from fresh birds from eastern Panama.

Intergradation takes place in the following manner. A series from eastern Costa Rica is obviously *fulvidior* in color, but has the shorter wing of *cinnamomeus*. A series from Almirante is more interesting, in that only two or three are obviously more richly colored than the balance. I consequently refer these Almirante birds to *cinnamomeus*.

Tityra semifasciata columbiana Ridgway

Permé, 2 ♂, 2 ♀; Obaldia, 1 ♀.

The females in their grayer less brown upperparts are clearly nearer *columbiana* than *costaricensis*. The adult male, if alone, would, however, have been referred to *costaricensis*, as the amount of black on the lateral rectrices does not show the slightest sign of the reduction characteristic of typical *columbiana*.

Querula purpurata (Muller)

Permé, 4 ♂, 1 ♀; Obaldia, 1 ♂; Ranchon, 1 ♂.

HIRUNDINIDAE

Riparia riparia (Linnaeus)

Obaldia, 3 ♀, Oct. 2, 6, 17, 1930.

Apparently the third record for Panama.

Hirundo rustica erythrogaster Boddaert

Permé, 3 ♂; Obaldia, 3 ♂, 1 ?.

Taken during the fall migration only, August 28, 1929 to November 4, 1930.

Progne chalybea chalybea (Gmelin)

Permé, 4 ♂; Obaldia, 10 ♂, 1 ♀, 3 ?.

Petrochelidon lunifrons melanogaster (Swainson)

Obaldia, 1 ♂, Oct. 6, 1930.

The small size and deep chestnut forehead render the identification positive. Not only is it the first record for Panama, but I do not recall any record for this subspecies outside the breeding range.

Stelgidopteryx ruficollis uropygialis (Lawrence)

Permé, 1 ♂.

CORVIDAE

Cyanocorax affinis zeledoni Ridgway

Permé, 3 ♂, 3 ♀; Ranchon, 2 ♂.

Like specimens from Cana on the Pacific slope, these birds are less yellow below than typical *zeledoni*, and thus approach true *affinis*.

TROGLODYTIDAE

Heleodytes albobrunneus harterti Berlepsch

Obaldia, 1 ♀.

Thryophilus nigricapillus reditus subsp. nov.

Type.— No. 155,797, Museum of Comparative Zoölogy; ♂ ad.; Permé, Caribbean slope of eastern Panama; August 31, 1929; H. Wedel.

Characters.— Immediately separable from *schotti* (Baird) of the Paci-

fic slope of Darien and Colombia in having the chin and throat immaculate white, as in typical *nigricapillus*; the sides, flanks, and abdomen and under tail coverts also a darker duller brown; easily separable, however, from typical *nigricapillus* in the darker chestnut upperparts, the shade averaging a little lighter than in *schotti*, about as in *connectens* Chapman. Thirty specimens, Permé and Obaldia.

It was a most unexpected surprise to find a new race of this Wren in the region treated, with the main character a reversion to that of the west Ecuador *nigricapillus* at the opposite extreme of the range. It is remarkable how variable many of the species of the Colombian-Pacific fauna are. This particular Wren is by no means unique.

The sexes of this species are usually described as alike, which is not quite the case. Females and young tend to have the barring extended further up the breast and throat than males in all races. Younger birds still tend to have the barring go right up to the chin, but the barring is coarser and broader than in adults.

Thryophilus leucopogon grisescens subsp. nov.

Type.— No. 155,820, Museum of Comparative Zoölogy; ♂ ad.; Permé, Caribbean coast of extreme eastern Panama; March 19, 1929; H. Wedel.

Characters.— Resembling typical *leucopogon* of northwestern Ecuador and western Colombia, but strikingly paler and grayer both above and below, the upperparts grayish brown rather than sepia.

Material examined

leucopogon.— Western Colombia: San José, Cauca, 1 ♀; Buena Vista, Narino, 1 ?. Panama: Pacific slope of Darien, Tapalisa, 1 ♀; Cituro, Cupé, 1 ♂.

grisescens.— Panama: Caribbean slope of Darien, Permé, 1 ♂; Ranchon, 1 ?; Obaldia, 1 ♂.

This rare and little known Wren is a typical member of the Colombian-Pacific fauna, and its discovery on the Caribbean coast is of great interest.

I am indebted to Dr. Chapman for the privilege of comparing our specimens with the American Museum examples of *leucopogon*. No topotypes of *leucopogon* exist in this country, but it would be most unlikely if the bird from Buena Vista should prove different. The two specimens from the Pacific slope of eastern Panama are intermediate, but a series would be required definitely to allocate them subspecifically.

The extremes are so distinct, that ample series in the future might indicate the existence of a third race.

THRYOPHILUS LEUCOTIS LEUCOTIS (Lafresnaye)

Permé, 1 ♂.

This specimen agrees with the type and another from Santa Marta in the color of the underparts, but is perhaps a little warmer brown above. It shows no real approach to *galbraithi* of the Canal Zone, which is merely a representative form. Not previously recorded from Panama.

PHEUGOPEDIUS FASCIATO-VENTRIS ALBIGULARIS (Sclater)

Permé, 8 ♂, 1 ♀; Obaldia, 2 ♂, 1 juv.

These specimens are much nearer the Canal Zone form in nearly every respect, but the unbarred area of black breast averages distinctly less, thus approaching the typical subspecies.

TROGLODYTES MUSCULUS INQUIETUS Baird

Permé, 6 ♂, 3 ♀, 1 ?; Obaldia, 3 ♂, 1 ♀.

This series in both color and size shows no approach to *striatulus*.

HENICORHINA LEUCOSTICTA DARIENENSIS Hellmayr

Permé, 7 ♂, 1 ♀, 1 ?; Obaldia, 7 ♂, 1 ♀, 4 ?.

LEUCOLEPIS PHAEOCEPHALUS ASSIMILIS Todd

Permé, 9 ♂, 6 ♀, 2 ?; Obaldia, 1 ♂, 2 ♀, 1 ?; Ranchon, 3 ♂.

MICROCERCULUS MARGINATUS PHILOMELA (Salvin)

Permé, 4 ♂, 1 ?; Obaldia, 1 ♂.

This tiny Nightingale Wren is famous both for its rarity in collections and the complicated series of plumages, which have served as the basis of numerous supposed species. In 1909 (cf. Proc. Biol. Soc. Wash., **22**, pp. 34–35) Outram Bangs was able to assemble a unique series of fourteen skins from Costa Rica and western Panama, and in his able critique of the various plumages gave strong reasons for regarding the four proposed Central American species as one form. More recently Hellmayr, Todd and Chapman in their well known works

on Venezuela, Santa Marta, Colombia and Ecuador have given further illuminating comments and have suggested the subspecific relationship of various proposed species, and the need for still further revision.

Thanks to Dr. Chapman's courtesy I have been able to reëxamine the extensive material from South America in the American Museum, and took to New York the specimens in Cambridge. Thus, no less than seventy-six specimens were before me at one time, including three types, and topotypes of every proposed form except *squamulatus*. I agree absolutely with all the comments alluded to above, and regard further changes as entirely warranted by the exceptional material at my command.

With thirty-eight specimens before me from Central America, it will perhaps be best to give a brief resumé of the various plumages of *philomela*. I give what I believe to be their proper sequence, but I am far from certain of this, nor am I prepared to hazard an opinion as to the length of time each is retained. I shall consequently give each plumage a number, and will allude to each by that number in the future, as occasion arises.

No. 1. Undoubtedly the first juvenal or immature plumage. Feathers of upperparts tipped with blackish, giving a squamate effect; underparts dirty, dingy, grayish brown, scarcely paler on throat than chest, the feathers obscurely tipped with dusky; sides and flanks also obscurely tipped with blackish. The feathers of the breast, when closely examined, prove to be dusky basally also. The effect produced depends, therefore, upon the make-up of the skin. Those made up short and close would be described as above. Old Guatemala trade skins with pouting or puffy breasts, however, with the feathers exposed practically to the base, would be described as having dusky brown breasts, each feather with a broad subterminal lunate bar of grayish brown. The looser, fluffier texture of the plumage is a further evidence of immaturity.

The description and the plate of the type in the Biologia shows that *philomela* Salvin is based on this plumage. Moreover, a specimen in New York marked "compared with type" is in this plumage.

The next stage is a clearer, paler gray throat, a clearer gray and broader subterminal bars below. The throat becomes whitish, the subterminal bars below become even paler, and we pass gradually into

No. 2. Throat whitish, the feathers with dusky bases, feathers of breast with *two* lunate bars of pale grayish or whitish, the tip *very narrowly* dusky. This tip disappears in worn specimens, and the breast appears dusky with lunate white tips. The lower, inner, or more basal

bar is not visible on the surface, unless adjacent feathers are lost. It tends to increase the pale lunate effect. Reference specimen, Museum of Comparative Zoölogy No. 121,311.

This plumage is by all odds the rarest in collections, and has usually been described as specifically distinct.

No. 3. A transition plumage to the fully adult stage. The feathers of the breast, etc., are the adult gray *to the base*, but the tip is dusky and the longer central feathers are freckled with dusky along the shaft. Museum of Comparative Zoölogy No. 121,315 is moulting on the breast, and the gray feathers are just coming in among the dusky ones.

This plumage is very common. Careful dissection shows that the bird breeds in this plumage. This plumage was first described as *M. daulias* Ridgway from eastern Costa Rica. Passing by insensible gradations into

No. 4. The fully adult plumage. Plumage uniform throughout; no dusky or blackish tips to the feathers of any part of the body.

This plumage is relatively uncommon, as some trace of dusky tipping somewhere is present in most specimens. It was first described as *M. luscinia* Salvin from Santa Fé, Veraguas. The type of *acentetus* Bangs is also fully adult.

I have fair to good series of three of these plumages from northern and southern Central America. No reliable color characters exist nor is there any appreciable difference in size, though southern birds tend to be a little larger. All birds from Guatemala to the Canal Zone must consequently be called *philomela* Salvin. Difficulties arise when we turn next to the series from extreme eastern Panama. For years there have been two specimens from Mt. Tarcacuna in New York, which Chapman has recently discussed (Birds Ecuador, p. 575). Just as he says, these birds clearly connect *philomela* with *antioquensis* Chapman, indicating the specific identity of these two groups, and I always supposed they represented an undescribed race. Two specimens in Cambridge from Mt. Sapo were similar, but the new series from Wedel shows a different state of affairs. Three out of a total of twelve are in plumage no. 4, and in color are absolutely indistinguishable from *philomela*. They have, however, the pronouncedly longer bills of the South American races. The balance are quite different from anything in Central America. They also are nearly adult (some definitely breeding) but have white or whitish throats, pale gray underparts, and the feathers of the abdomen have whitish tips and subterminal dusky bars. These markings are somewhat irregular and

erratic, and no two individuals are exactly alike. These specimens connect *corrasus* and *antioquensis* with *philomela*, and provide a valuable clue to a proper understanding of the South American races. The only definitely breeding male is in this plumage.

From eastern Darien southward we have a perfect series of transitions to *marginatus*, extreme adult specimens of which from northeastern Peru are pure white below, with no dusky bars left at all. Speaking somewhat generally and loosely, the pure white adult *marginatus* passes through intermediate races to the uniform gray *philomela*. It follows that the more adult stages of the intermediate races are *never uniformly colored* below, but are first gray, squamulated with white (*squamulatus* and *corrasus*); next, more pronouncedly barred with white (*antioquensis*); next, broadly barred brownish and white throughout (*taeniatus*); abdomen only barred with brown (*marginatus occidentalis*); no brown bars (*marginatus*).

It also follows that the various immature plumages of the whiter races superficially resemble the adult plumages of more barred or squamulated races. The following tentative arrangement is proposed.

1. *marginatus marginatus*. Brown areas rich dark umber.

   Plumage no. 1. Upperparts with dusky tips to feathers; white feathers of throat and breast with dusky brownish tips; center of abdomen both barred with brownish and tipped with dusky. This plumage closely resembles in pattern below the adult of *squamulatus*, but differs in the color of the upperparts, and above all the dusky tips above, an infallible sign of immaturity.

   Plumage no. 2. Unknown and unrecorded.

   Plumage no. 3. No dusky tips above; uniform white below, with brownish barring in various amounts, surviving latest on abdomen. Such specimens indistinguishable in pattern below from adults of the bird currently known as *marginatus occidentalis* Hellmayr.

   Plumage no. 4. Uniform white, unbarred below. Also described as *bicolor* Des Murs. Rare in collections. A total of twenty specimens examined.

2. *marginatus taeniatus*. Brown areas darker, more chocolate; bill longer.

   Plumage no. 1. Perhaps a little more heavily marked and barred below than *marginatus*.

   Plumage no. 2. The type of *taeniatus*, judging by the description and plate.

Plumage no. 3. Tending to be more heavily marked with brown on throat and breast. Variously labeled *taeniatus* or *marginatus occidentalis* in collections.

Plumage no. 4. As in *marginatus*, but abdomen always crossed with bars. Excellently described with full comparative data as *marginatus occidentalis* Hellmayr. A total of thirteen specimens examined.

3. *marginatus antioquensis*. Brown areas rich umber, as in *marginatus*.

Plumages 1 and 2. Unknown.

Plumages 3 or 4. Differing from *taeniatus* in having the feathers of throat and breast dusky with narrower white subterminal areas.

The type and two other specimens examined from the Atrato Valley, Colombia. A poorly known intermediate form. In the pattern below it is suspiciously close to juvenal specimens of *taeniatus*, but differs from that race in the color of the brown areas.

4. *marginatus corrasus*. Bill slightly shorter; brown areas much paler, less rufescent.

Plumages 1 and 2. Apparently unrecorded.

Plumage 3. Feathers of abdomen and breast grayish basally, followed by a narrow dusky bar, a whitish subterminal area, another narrow dusky bar, and a very narrow pale tip, rapidly worn off. This barring much narrower than in *antioquensis*. Upperparts with faint dusky tips.

Plumage 4. Not definitely known. I do not believe that any of the four specimens in American Museums are fully adult. The type and one other specimen examined in this connection.

5. *marginatus squamulatus*. Brown areas said to be more rufescent in "adults."

Plumage 1. See Hellmayr and Seilern, Arch. f. Naturg., **78**, 1912, pp. 44 and 45.

Plumage 2. The type of *M. pectoralis* Richmond and Robinson.

Plumage 3 or 4. Said by Todd to be less narrowly barred below. Well described by Hellmayr and Seilern. It will be seen that the color characters alleged to separate *corrasus* and *squamulatus* are those which would exist between plumages 3 and 4 of any race. If *corrasus* is tenable it will be on the basis of a shorter wing, 55 mm. versus 60–63 in *squamulatus*. Hellmayr and Seilern in the paper cited show that *taeniatus* is only subspecifically separable from *squamulatus*.

The east Darien specimens already discussed are in plumages 3

and 4. The whole series differs from *philomela* in any plumage by having the longer bill of the South American races. Fully adult birds are inseparable from *philomela*, but younger specimens differ in having whitish subterminal areas to the feathers of the abdomen. These differ from *squamulatus* or *corrasus* in having the *abdomen only* affected, the latter having the feathers of the breast affected as well. An extreme specimen from Mt. Sapo on the Pacific slope, however, is, if anything, nearer to the type of *corrasus* than to any specimen in similar plumage from Central America. I see no point in describing so indefinite and variable an intermediate. My own preference would be to recognize only *philomela*, *squamulatus*, *taeniatus* as here construed, and *marginatus*, until such time as larger series and a proper representation of the various plumages proves the constancy and definiteness of minor characters in smaller geographic areas.

TURDIDAE

Turdus obsoletus colombianus Hartert and Hellmayr

Obaldia, 3 ♂, 1 ♀, 1 ?.

These birds are all immature except one, but none are true *obsoletus*, and in color of upperparts are clearly *colombianus*. In the underparts, however, they do not quite agree with specimens from the Pacific side of Darien, which are apparently *colombianus*. Whether these differences are due to immaturity or are of racial value can only be decided by a series of adults. In the meantime the probabilities are in favor of the former hypothesis.

Hylocichla ustulata swainsoni (Tschudi)

Permé, 1 ♀, April 22; 1 ♂, July 4; 1 ♂, Nov. 9th.

The July record is the first summer record that I can recall from Panama for a North American species other than shore birds.

SYLVIIDAE

Polioptila bilineata bilineata (Bonaparte)

Permé, 1 ♀; Obaldia, 1 ♂, 2 ♀.

Ramphocaenus rufiventris rufiventris (Bonaparte)

Permé, 2 ♂, 1 ♀.

Microbates cinereiventris magdalenae Chapman

Permé, 3 ♂, 1 ♀; Obaldia, 2 ♂, 3 ♀, 1 ?; Ranchon, 1 ♂, 1 ♀, 1 ?.

This series is on the whole nearer *magdalenae* than *semitorquatus* (Lawrence). The tail is tipped with whitish, the most definite character of *magdalenae*, and the upperparts average distinctly paler. In the underparts, however, only four specimens are noticeably paler than a large series of *semitorquatus* from Costa Rica to the Canal Zone. Nor do I find any difference in bill and tail length. The absence of a brown postocular stripe shows that my birds have nothing to do with typical *cinereiventris*, which is known to range northward to the Pacific slope of Darien.

VIREONIDAE

Vireo calidris barbatula (Cabanis)

Obaldia, 1 ?, Sept. 12, 1930.

Apparently only one previous record for Panama exists for the Black-whiskered Vireo, a specimen forwarded by McClennan to Salvin from the Canal Zone, and never determined subspecifically. The present specimen is unquestionably this subspecies, which is known to winter along the north coast of South America.

Vireo flavoviridis flavoviridis (Cassin)

Permé, 1 ♀, Sept. 3, 1929.

I entirely concur in the subspecific determination, originally made by Mr. Peters. The specimen is undoubtedly a transient.

Vireo olivaceus (Linnaeus)

Permé, 1 ♂, 1 ♀, 1 ?; Obaldia, 1 ?; March 28–April 17; Aug. 14–Nov. 25.

I have yet to see any evidence to show that the Red-eyed Vireo winters with any regularity in any part of Central America.

Hylophilus ochraceiceps bulunensis Hartert

Obaldia, 1 ♀; Ranchon, 1 ♀.

These agree with three specimens from Mt. Sapo on the Pacific slope of Darien, but are perhaps a trifle less yellow below. In this respect,

they show a faint approach to the Amazonian *ferrugineifrons*. I heartily agree with Chapman that the latter is a representative form only.

Hylophilus minor darienensis Griscom

Permé, 1 ♂, 1 ?; Obaldia, 2 ♂, 3 ♀.

This excellent series abundantly confirms the validity of this recently described form.

COEREBIDAE

Coereba mexicana columbiana (Cabanis)

Obaldia, 3 ♂, 3 ♀.

This is the first series of *Coereba* to become available from eastern Darien, and establishes the correctness of referring the two previously recorded specimens to this race.

Dacnis cayana ultramarina Lawrence

Permé, 5 ♂, 2 ♀; Obaldia, 3 ♂, 2 ♀.

The series is far from typical. Two males are as purple as several from the Pacific coast of Colombia, and one is still more purple, though by no means the extreme of *coerebicolor*.

Dacnis venusta fuliginata Bangs

Permé, 7 ♂, 3 ♀; Obaldia, 3 ♂, 1 ♀.

This excellent series is obviously intermediate, but on the whole nearer *fuliginata*.

Cyanerpes lucidus isthmicus Bangs

Permé, 2 ♂; Obaldia, 10 ♂, 5 ♀.

As might have been expected, this series averages distinctly smaller than Canal Zone specimens. The species has not been recorded from Panama east of the Canal Zone. A very few miles further south in Colombia *C. coeruleus* would appear to be fairly common.

Chlorophanes spiza arguta Bangs and Barbour

Permé, 1 ♂; Obaldia, 7 ♂, 1 ♀.

COMPSOTHLYPIDAE

Mniotilta varia (Linnaeus)

Permé, 1 ?, March 15; Obaldia, 1 ♀, Oct. 17, 1 ?.

Protonotaria citrea (Boddaert)

Permé, 1 ?, Oct. 18; Obaldia, 1 ♂, Sept. 15.

Vermivora peregrina (Wilson)

Permé, 1 ♂, Dec. 2.

Dendroica aestiva aestiva (Gmelin)

Permé, 1 ♂, 3 ♀; Obaldia, 1 ♂, 1 ♀, Aug. 24, 1930, 1 ♀ (mid-winter).

Dendroica fusca (Muller)

Obaldia, 2 ?, Oct. 12, 13.

Dendroica castanea (Wilson)

Permé, 3 ♂, 2 ♀, 2 ?, Nov. 13–April 4; Obaldia, 1 ♀, 1 ?.

Seiurus motacilla (Vieillot)

Permé, 1 ♂, Sept. 8; Ranchon, 1 ♂, Feb. 4.

Seiurus noveboracensis noveboracensis (Gmelin)

Permé, 4 ♂, 2 ♀, 1 ?; Obaldia, 2 ♂, 2 ♀, Sept. 18–April 5.

Two of these specimens are intermediate and approach *notabilis* in the whiter underparts.

Wilsonia canadensis (Linnaeus)

Obaldia, 1 ♂, 1 ♀, Oct. 1, 13.

Setophaga ruticilla (Linnaeus)

Obaldia, 1 ♀, Nov. 20.

Phaeothlypis fulvicauda semicervina (Sclater)

Obaldia, 3 ♂, 3 ♀, 4 ?.

ICTERIDAE

Zarhynchus wagleri wagleri (Gray)

Permé, 1 ♂, 4 ♂; Ranchon, 1 ♂.

Cacicus vitellinus Lawrence

Permé, 2 ♂, 3 ♀.

Cacicus microrhynchus (Sclater and Salvin)

Permé, 3 ♂, 1 ♀; Obaldia, 1 ♂.

Amblycercus holosericeus holosericeus (Lichtenstein)

Permé, 1 ♂, 1 ♀.

Psomocolax oryzivorus violeus Bangs

Permé, 1 ♂, 1 ♀.

Dolichonyx oryzivorus (Linnaeus)

Permé, 1 ♀ (Oct. 18, 1929); Obaldia, 1 ♂, 3 ♀, Sept. 30–Oct. 10, 1930.

Icterus galbula (Linnaeus)

Obaldia, 1 ♀, March 4, 1931.

Icterus spurius (Linnaeus)

Permé, 2 ♂, 2 ♀, Aug. 3, Aug. 5, and Sept. 12.

Icterus giraudii giraudii Cassin

Permé, 5 ♂, 3 ♀, 1 ?; Obaldia, 1 ♂, 1 ♀.

THRAUPIDAE

Tanagra olivacea humilis (Cabanis)

Obaldia, 1 ♂.

Tanagra fulvicrissa fulvicrissa (Sclater)

Permé, 1 ♂; Obaldia, 3 ♂; Ranchon, 1 ♂.

Tanagra crassirostris crassirostris

Permé, 4 ♂; Obaldia, 1 ♂.

Tangara inornata languens Bangs and Barbour

Permé, 2 ♂, 2 ♀; Obaldia, 2 ♂, 5 ♀.

This series shows so very little approach to the darker *inornata* that there is no reasonable question of the identification.

Tangara gyroloides gyroloides (Lafresnaye)

Obaldia, 6 ♂, 4 ♀.

Tangara larvata fanny (Lafresnaye)

Permé, 7 ♂; Obaldia, 2 ♂.

Thraupis cana cana (Swainson)

Permé, 4 ♂, 1 ♀, 1 ?; Obaldia, 1 ♀.

Thraupis palmarum melanoptera (Sclater)

Permé, 2 ♂, 1 ♀, Obaldia, 1 ♂.

Ramphocelus icteronotus Bonaparte

Permé, 7 ♂, 3 ♀.

Ramphocelus dimidiatus dimidiatus Lafresnaye

Permé, 3 ♂, 12 ♀.

Piranga rubra rubra (Linnaeus)

Permé, 7 ♂, 2 ♀; Obaldia, 3 ♀, Oct. 2–April 5.

Chlorothraupis carmioli lutescens Griscom

Permé, 5 ♂, 2 ♀, 1 ?; Obaldia, 8 ♂, 4 ♀, 1 ?; Ranchon, 5 ♂, 2 ?.

This series is by no means as yellow below as the type series from the Pacific side of Darien.

Heterospingus rubrifrons (Lawrence)

Obaldia, 1 ♀.

The small size of this specimen makes it *rubrifrons* unquestionably. It has not previously been recorded east of the Canal Zone. The specimen recorded by Bangs and Barbour (Bull. Mus. Comp. Zoöl., **65**, 1922, p. 228) as *H. xanthopygius* is a juvenal of *rubrifrons* on size characters also, the only reliable one, except for adult males (cf. Hellmayr, Proc. Zoöl. Soc. London, 1911, p. 1,114).

Tachyphonus rufus (Boddaert)

Permé, 1 ♂.

Tachyphonus luctuosus panamensis Todd

Permé, 4 ♂, 4 ♀; Obaldia, 2 ♂, 6 ♀.

Eucometis cristata cristata (Du Bus)

Permé, 6 ♂, 4 ♀.

Mitrospingus cassini cassini (Lawrence)

Permé, 3 ♂, 1 ♀, 1 ?; Obaldia, 4 ♂, 5 ♀, 1 ?; Ranchon, 1 ♂.

FRINGILLIDAE

Cyanocompsa cyanoides cyanoides (Lafresnaye)

Permé, 6 ♂, 2 ♀, Ranchon, 2 ♂, 1 ♀.

Sporophila schistacea schistacea (Lawrence)

Obaldia, 10 ♂ taken in July and August, nearly all breeding.

Sporophila aurita aurita (Bonaparte)

Permé, 3 ♂, 2 ♀; Obaldia, 1 ♂, 1 ♀.

Volatinia jacarini atronitens Todd

Permé, 3 ♂; Obaldia, 2 ♂.

Pitylus grossus (Linnaeus)

Permé, 1 ♂, 2 ♀; Obaldia, 1 ♂; Ranchon, 2 ♂, 1 ♀.

Spiza americana (Gmelin)

Permé, 3 ♂, 2 ♀; Obaldia, 2 ♂, 1 ♀, Sept. 11–May 10.

Arremonops striaticeps striaticeps Lafresnaye

Permé, 2 ♂, 1 ♀; Obaldia, 4 ♂, 6 ♀, 1 ?.

Arremon aurantiirostris strictocollaris Todd

Permé, 1 ♂, 1 ♀.

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AT HARVARD COLLEGE

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NEW REPTILES AND AMPHIBIANS FROM TANGANYIKA TERRITORY AND KENYA COLONY

BY ARTHUR LOVERIDGE

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No. 10.— *New Reptiles and Amphibians from Tanganyika Territory and Kenya Colony*

By Arthur Loveridge

The following descriptions have been abstracted from the main body of a report dealing with 4,876 reptiles and amphibians collected by the author during an eight months' expedition in East Africa in 1929–30. It is hoped that this report will appear as a Bulletin of the Museum of Comparative Zoölogy later in the year, but as these descriptions have already been in typescript nearly a year it is considered inadvisable to delay their publication longer.

The first three forms are little more than color races, the naming of which is a practice generally to be deprecated. The salmon-colored marking on the mountain form of wolf snake is, however, so strikingly different from the ordinary drab and plumbeous hue of the well-known and widespread Cape Wolf Snake that it may merit recognition.

In the case of the agamas the gorgeous throat coloring of the males is of great importance in their sexual display and no overlapping has been observed in the large series of the other named races; in scale-counts, however, there is some overlapping in geographically adjacent areas, though series from the extremes of the range of the species are distinct. A colored plate of these distinctively marked throats has been prepared for publication with the report. In this paper the descriptions are abridged as far as possible.

Lycophidion capense uzungwensis subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 30,117. A ♂ from Dabaga, Uzungwe Mountains, Tanganyika Territory, collected by Arthur Loveridge, January 1, 1930.

Paratype.— Museum of Comparative Zoölogy, No. 30,118. A ♀ from Kigogo, Uzungwe Mountains, Tanganyika Territory, collected by Arthur Loveridge, January 23, 1931.

Diagnosis.— Differs from *Lycophidion c. capense* in possessing a bright salmon-colored, ∩-shaped band following the contour of the

snout. It agrees with the typical form in lepidosis and scale counts, which are as follows:

	♂ Type	♀ Paratype
Midbody scale rows	17	17
Ventrals	177	193
Anal	1	1
Subcaudals	30	22
Labials	8–8	8–8
Labials entering orbit	3d, 4th, 5th	3d, 4th, 5th

Coloration in life.— ♂. Above, blue-black, each scale with a white spot posteriorly; a ∩-shaped salmon-colored band follows the outline of the snout, being on the upper half of the labials, most of the prefrontals, outermost corner of the frontal, outer edge of the parietals, all of the upper temporals and the other anterior head shields, including the pre- and post-oculars. Below blue-black, each ventral and caudal scute with a pair of white streaks near the sides. In alcohol the band fades to pinkish white.

Measurements.— Type ♂. Head and body 195 mm., tail 24 mm. Paratype ♀. Head and body 255 mm., tail 20 mm.

Agama agama turuensis subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 30,686. A ♂ from rocks in arid, semi-desert, thorn-bush country of Unyanganyi, east of Singida, Tanganyika Territory, collected by Arthur Loveridge, December 3, 1929.

Paratypes.— Museum of Comparative Zoölogy, Nos. 30,687–30,735 and unnumbered duplicates from the type locality and from Mangasini, Usandawi, Tanganyika Territory, collected by Arthur Loveridge, December 12, 1929.

Diagnosis.— The males of this new form differ from those of all other races of *Agama agama* in possessing a black ∪-shaped marking on the base of their otherwise uniformly brick red throats.

Midbody scale rows 78 (range in paratypes 72–82, with an average of 76 for fifty specimens); preanal pores 12 (range 9–14, with an average of 11.3 for thirty-four males; No. 30,691 has a double row of pores, each with 11 but only the posterior row is counted in assessing the average).

Coloration in life.— Above, the head as far as the shoulders is a rich brick-red, the back dark blue spotted with light blue; hind limbs and base of tail light blue, rest of tail dark blue. Below, throat and neck

rich brick-red, except for a black U-shaped mark, sixteen scales in width, on the base of the throat; the underside of body and fore limbs are dark blue except for an irregular patch of white on the belly; hind limbs and tail light blue.

Measurements.— Type ♂. Head and body 109 mm., tail 184 mm. Largest paratype ♀. Head and body 115 mm., tail 182 mm.

The measurements of the type are far surpassed in length from snout to vent by many of the paratype males which, however, as is usual with adult agamas, have lost the ends of their tails; the greatest head and body length of any male of the series is 140 mm.

Agama agama ufipae subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 30,741. A ♂ from rocks on the shore of Lake Tanganyika just across the bay from Kipili, Ufipa, Tanganyika Territory, collected by Arthur Loveridge, May 19, 1930.

Paratypes.— Museum of Comparative Zoölogy, No. 30,742–30,745. Four ♀ ♀ collected at the same place and time as the type.

Diagnosis.— The males of this new form differ from those of all other East African races of *Agama agama* in possessing a wholly blue throat instead of orange, carmine or red.

It has an exceptionally high average (series small, however) number of midbody scale rows and number of preanal pores. Approaches *A. a. lionotus* and *A. a. mwanzae* in the very obtuse keeling of the dorsal scales of which there are 54 on the vertebral line between the origin of the fore limbs and the origin of the hind limbs; midbody scale rows 84 (range in paratypes 78–84, with an average of 82); upper labials 10; lower labials 9–10 (range 9–11 upper and 9–11 lower); 4th finger a trifle longer than the 3d; preanal pores 15; tail flattened, its strongly spinose and mucronate scales forming annuli.

Coloration in life.— ♂. Above, crown of head and nape a pale yellowish brick-red with numerous cream-colored spots; back and tail, various shades of green and blue, a lighter, almost bluish white, vertebral streak, the whole dorsal area speckled with lighter; tail transversely ringed with light bands except on the broadened basal portion; fore limbs blue; hind limbs pale verdigris-green blotched with darker. Below, labials buff, throat a pale navy-blue margined with light red laterally posterior to the angles of the mouth, three black spots which are ringed with white, across the hind end of the throat, posterior to them is an ill-defined blackish area; region of shoulders,

breast, a diamond-shaped central area of the belly, as well as patches on the posterior aspect of the thighs, navy-blue but lighter than on the throat, sides of belly and lower surface of hind limbs bluish green merging to white on the base of the tail; lower sides of the fore limbs pale blue, soles of all four feet white.

Measurements.— Type ♂. Head and body 118 mm., tail injured. Paratype ♀. Head and body 85 mm., tail 148 mm.

ZONURUS UKINGENSIS sp. nov.

Type.— Museum of Comparative Zoölogy, No. 30,761. A ♂ from Tandala, Ukinga Mountains, southwestern Tanganyika Territory, collected by Arthur Loveridge, February 11, 1930.

Diagnosis.— Agrees with the *cordylus* group in having the frontonasal separated from the rostral by the nasals, absence of occipital spines and supranasal, the nostril being in a large nasal, a scaly lower eyelid, large lateral scales, a frontonasal, nasal not strongly swollen.

It differs from all of the *cordylus* group in lacking a loreal which is correlated with the presence of an enormous preocular; also in its possession of sharply keeled temporals and obtusely keeled ventrals.

It also differs from *Z. c. jonesi* in the much greater development of mucros and keels on all parts of the body.

It also differs from *Z. c. cordylus* in the short blunt head which is not so depressed and in the reticulate ribbing of the dorsal scales which it shares with *Z. c. jonesi.*

A complete description will be published in due course.

Coloration in life.— ♂. Above, dark sepia-brown, mottled with ochraceous brown; scattered over the flanks are light-colored scales. Below, white, faintly mottled with gray.

Measurements.— Type ♂. Head and body 54 mm., length of head 16 mm., breadth of head 12 mm., length of tail 33 mm.

Comparative material.— In addition to thirteen of the South African species including *Z. c. jonesii* which appears to be the nearest relative of this new zonure, the Museum of Comparative Zoölogy possesses the type of *Z. tropidosternum* Cope and three specimens from near the type locality of its synonym *Z. frenatus* Pfeffer, described from Mhonda, Tanganyika Territory.

AMPHISBAENA MPWAPWAENSIS sp. nov.

Type.— Museum of Comparative Zoölogy, No. 30,767. A ♂ from Mpwapwa, Ugogo, Tanganyika Territory, collected by Arthur Loveridge, November 22, 1929.

Paratype.— Museum of Comparative Zoölogy, No. 30,768. A ♀ taken with the type.

Diagnosis.— Of similar appearance to *Amphisbaenula orientalis* from which it differs in possessing *an ocular*[1] scale which *separates* the frontal from the first labial, which is the *smallest;* second labial *largest;* three scales bordering the upper lip besides the rostral; the first being a fusion of prefrontals, nostril, and former first labial; followed by two upper labials; a pair of frontals forming a *sexagon;* a pair of parietals *smaller* than the frontals; chin-shields 1+3+4; temporals 2, the uppermost being in contact with the frontal; *273* body segments; *30* midbody annuli (*14* above, *16* below); *26* caudal annuli; 6 preanal pores.

In the paratype the outline of frontals and parietals is less regular than in the type; chin-shields 1+4+4; temporals 3 (the larger upper one of the type being divided horizontally); *269* body segments; 5 preanal pores, very indistinct.

Coloration in life.— ♂, ♀. Flesh-pink.

Measurements.— Type ♂. Head and body 175 mm., tail 19 mm. Paratype ♀. Head and body 147 mm., tail 15 mm.

Comparative material.— Though a true *Amphisbaena*, this lizard is most nearly related to *Amphisbaenula orientalis* Sternfeld from Mikindani, southeastern Tanganyika Territory, of which a cotype is in the Museum of Comparative Zoölogy (No. 21,904). *Amphisbaenula* is at most a subgenus only, distinguished from *Amphisbaena* by the absence of an ocular.

Mpwapwa is the type locality of *Geocalamus modestus* Günther, represented in the Museum of Comparative Zoölogy by two specimens collected by the author some years ago. *Geocalamus* is an entirely different creature from that just described above.

Chamaeleon werneri dabagae subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 31,344. An adult ♀ from the bamboo forest near Dabaga, Uzungwe Mountains, Tanganyika Territory, collected by Arthur Loveridge, January 1, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 31,345–31,348. Both sexes, collected at the same time as the type.

Diagnosis.— Agreeing in all respects with *C. werneri werneri* except that the female is hornless, or has a very rudimentary horn, while that of the type of *werneri* as figured by Tornier, as well as five pre-

[1] Points in which it differs from *orientalis* are italicized.

sumably topotypic females of *werneri* from the southern end of the Uzungwe range, possess a large, well-developed rostral horn.

In the smaller paratype female (No. 31,348) there is a rudimentary horn less than a millimetre in length. In view of the wide range of variability in chameleons it may be somewhat rash to describe a new form on the basis of so small a series. There are, however, parallel cases in other horned chameleons which hold good, as for example:

Female hornless	Female horned
C. jacksoni jacksoni Boulenger	*C. jacksoni vanereseeae* Tornier
C fischeri fischeri Reichenow	*C. fischeri multituberculatus* Nieden

Measurements.— Type ♀. Head and body 91 mm., tail 96 mm. Paratype ♂. Head and body 96 mm., tail 109 mm.

Comparative material.— Ten examples of *C. werneri werneri* from Kigogo and Mufindi East at the southern end of the Uzungwe Mountains, and an almost complete collection of East African chameleons.

Chameleon incornutus sp. nov.

Type.— Museum of Comparative Zoölogy, No. 31,350. An adult ♂ from the forest edge at Madehani, Ukinga Mountains, southwestern Tanganyika Territory, collected by Arthur Loveridge, February 14, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 31,351–31,355 being 11 specimens from Madehani, collected February 14–28, 1930; Nos. 31,356–9 being 4 specimens from Nyamwanga, Poroto Mountains, collected April 17, 1930; Nos. 31,360–4 being 5 specimens from Nkuka Forest, Rungwe Mountain, collected March 19–30, 1930.

Diagnosis.— No gular or ventral crest of enlarged scales, no beard-like gular scales, no horn-like processes in either sex, no fin-like dorsal crest.

Well-developed occipital flaps fused in a short median suture behind the casque; a decidedly indistinct parietal crest forked anteriorly; a low dorsal crest comprised of sharply spinose scales (well separated or in groups of two or three followed by an interspace) from the nape to the base of the tail.

A more detailed description will appear later.

Coloration in life.— Type ♂. Above, crown of head pale reddish brown with bright chestnut-red bars which almost form three chevrons; bars of the same shade on the eyelid are very conspicuous; the vertebral line is flanked on either side by a greyish brown band; below this band is a broader, less sharply defined one of vivid emerald green inter-

rupted in three places by vertical, olive markings proceeding from three, more or less circular, olive-bordered, pale blue patches on the flanks; the intervening spaces between these patches are whitish; below this area the flanks are bright emerald green though not such a vivid shade as that of the cheeks or lower edge of the occipital flaps; the upper side of the limbs is the same less brilliant green as on the flanks. Throat greenish anteriorly and on the margins, the center white, which continues as a narrow band along the belly and the underside of the tail.

Measurements.— Type ♂. Head and body 84 mm., tail 77 mm. Largest paratype ♀. Head and body 93 mm., tail 95 mm.

Chamaeleon laterispinis sp. nov.

Type.— Museum of Comparative Zoölogy, No. 31,386. An adult ♂ from the forest edge above the forestry house at Kigogo, near Mufindi, Uzungwe Mountains, Tanganyika Territory, collected by Arthur Loveridge, January 23, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 31,387–8. Two adult ♂♂ collected in the same vicinity as that of the type during January, 1930.

Diagnosis.— This small chameleon seems to hold a somewhat isolated position with no near relatives. It is characterized by its very spinose appearance, not only a dorsal ridge of large, distinct spines, but equally large ones growing at right angles from the flanks.

A more detailed description will appear later.

Coloration in life.— Type ♂. Above olive brown; a black line with a white one below it passes from the posterior edge of the eye to the margin of the casque; a light greenish white, dorso-lateral line along either side connected with three areas of the same color on the flanks, the intermediate areas consisting of black, somewhat hourglass-shaped patches linked with similarly colored saddle-like blotches whose narrow necks cross the dorso-lateral line; there are on this line three pairs of white thorn-like spines which are thrown into sharp relief by the velvety black line passing between each pair. Seven black saddles on the tail. Below, buffy brown.

Measurements.— Type ♂. Head and body 67 mm., tail 62 mm.

Boulengerula changamwensis sp. nov.

Type.— Museum of Comparative Zoölogy, No. 16,301 from Changamwe, near Mombasa, Kenya Colony, collected by Arthur Loveridge, October 31, 1929.

Paratypes.— Museum of Comparative Zoölogy, Nos. 16,302–16,304, collected at the same place and time as the type.

Diagnosis.— Intermediate between *B. uluguruensis* Barbour and Loveridge of the Uluguru Mountains, Tanganyika Territory and *B. denhardti* Nieden of the Tana region; ultimately this new species may have to be united with the latter from which it is distinguished by the smaller number of annuli (vide Loveridge, 1930, Proc. Zoöl. Soc. London, p. 9, for key to the species).

Habit slender, vermiform. Snout obtusely pointed, projecting far beyond the lower jaw; eye indistinguishable; tentacle round, exsertile, with indications of a circular groove surrounding it, placed about halfway along the head just above the middle of the upper jaw; 18 teeth round the upper jaw; 152 annuli (150–152 in the paratype series), these annuli are interrupted on the middle dorsal line except on the nape and on the tail.

Coloration in life.— A livid flesh-pink, perhaps a little brighter than in *B. uluguruensis*. *In alcohol* it becomes opaque and colorless except for an ill-defined greyish dorsal area.

Measurements.— Type. Total length 207 mm., midbody diameter 4.5 mm. Paratypes. Total length 152–163 mm., midbody diameter 3.5–4 mm.

Bufo parkeri sp. nov.

Type.— Museum of Comparative Zoölogy, No. 16,330. An adult ♂ from swamped flats below Mangasini Village, Usandawi, Tanganyika Territory, collected by Arthur Loveridge, December 14, 1929.

Paratypes.— Museum of Comparative Zoölogy, Nos. 16,331–16,350 being 29 specimens of both sexes, many taken in embrace, at the same place and time as the type.

Diagnosis.— In the field these toads were identified as being near *Bufo vittatus* Boulenger of Entebbe, Uganda. Later, specimens were submitted to Mr. H. W. Parker of the British Museum for favor of comparison with the type of *vittatus*. He writes: "*Bufo vittatus* differs in the less raised canthus rostralis; more rounded snout; large, circular, very well marked tympanum measuring three-quarters the diameter of the eye; much longer fingers and toes; single sub-articular tubercles, much less spinose hands and feet; longer hind limbs, the tip of the 5th toe extending well past the tip of the snout (*vide* anterior border of eye in Mangasini toad); the digital length can be shown by the length of the foot (measured from the tip of the 4th toe to the proximal side of the outer metatarsal tubercle), being contained in the length from

snout to vent 2.25 times in *B. vittatus* and 3 to 3.25 times in the toad from Mangasini."

A complete description will appear later. The species is named in appreciation of Mr. Parker's kindness in making comparison of this and other specimens with the types in his care.

Coloration in life.— Above, in both sexes, muddy black corresponding to the black cotton soil on which they were found, warts ochraceous or very dull brownish red. Below, the throat of the type and other males was dull chrome, that of the females white like the rest of the underparts. *In alcohol.* Above, grey with blotches of darker and some of the warts lighter, a V-shaped interorbital marking like that of *B. r. regularis.*

Measurements.— Type ♂. Head and body 29 mm., length of foot 9 mm. Range in 13 paratype ♂♂. Head and body 27–30 mm., with an average of 29 mm. Range in 7 paratype ♀♀. Head and body 31–32 mm., with an average of 32 mm.

Bufo urunguensis sp. nov.

Type.— Museum of Comparative Zoölogy, No. 16,376. An adult ♀ from the remnant of rain forest at Kitungulu, Urungu, Tanganyika Territory, collected by Arthur Loveridge, May 14, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 16,377–16,379, taken at the same place and time as the type.

Diagnosis.— Differs from *parkeri* sp. nov. in the interorbital space being flat instead of concave, the tympanum rounded instead of vertically elongate, the tibio-tarsal articulation of the adpressed hind limb reaching to the axilla instead of to the middle of the flank as in *parkeri.*

Crown without bony ridges; snout short, truncated, with very distinct canthus; interorbital space flat, equal in width to an upper eyelid; tympanum small but quite distinct, round, its diameter scarcely half that of the eye. Fingers long and rather pointed, first considerably shorter than the second; toes provided with minute lateral spines, not, or but scarcely, webbed at the base, paired conical subarticular tubercles. soles of feet covered with spinose or sharply conical tubercles, two conspicuous conical metatarsal tubercles, no tarsal fold; the tibio-tarsal articulation of the adpressed hind limb reaches the axilla while the metatarsal tubercles scarcely reach to the eye. Upper parts very rough by reason of the numerous little warts surmounted by sharp spines, the warts vary considerably in size.

Coloration in life.— ♀. Above, grey tinged with brick-red and a trace of purple, a paler area on the snout extends backwards between the eyes and then branches so as to cover the parotid glands; several dark brown blotches, irregular in shape and position, but usually a V-shaped one, with apex directed posteriorly, just above the anus. Below, creamy white speckled with purple, a concentration of these specks upon the chest and along the median ventral line; soles of hands and feet dark, the tubercles conspicuously white.

Measurements.— Type ♀. Head and body 28 mm., snout to back of tympanum 7.5 mm., length of hind limb 23 mm., length of longest toe 4 mm. The paratype series ranges in length of head and body from 19–29 mm.

Rana mascareniensis uzungwensis subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 16,626. An adult ♀ from Dabaga, Uzungwe Mountains, Tanganyika Territory, collected by Arthur Loveridge, January 1, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 16,627–16,639 from Dabaga and Kigogo, Uzungwe Mountains and Lukungu, Ubena Mountains, Tanganyika Territory, collected between January 1 and February 8, 1930, also three specimens in the British Museum from "Benguella to Bihé, Angola."

Diagnosis.— Closely related to *mascareniensis*, from which it may be distinguished by the less extensive webbing of the hind feet and very different, more brilliant coloration in life, though the latter is not noticeable in preserved material. A comparison with the cotype ♀ of *mascareniensis* from Madagascar in the collection of the Museum of Comparative Zoölogy shows the following differences:

R. m. mascareniensis ♀ cotype	*R. m. uzungwensis* ♀ type
Joints of 1st toe free of web 1	$1\frac{1}{2}$ joints free of web
Joints of 2d toe free of web 1	$1\frac{1}{2}$ joints free of web
Joints of 3d toe free of web 1	$1\frac{1}{2}$ joints free of web
Joints of 4th toe free of web 2	3 joints free of web
Joints of 5th toe free of web 1	1 joint free of web

When first seen in the field I decided that these frogs were not *mascareniensis* nor any member of the genus with which I was acquainted; they were subsequently submitted to Mr. H. W. Parker for his views before describing; he replied as follows: "Boulenger, as you know, revised *Rana* but never published his views. Our col-

lection was labeled according to his findings and he recognized four 'varieties' of *mascareniensis*, viz.: *R. m. mascareniensis*, *R. m. mossambicus* Peters, *R. m. venusta* Werner and *R. m. benguellensis*. Do you know the author of the last name? I do not, and think it must be a manuscript name only. At any rate that is what these two Dabaga frogs are. We have three specimens, locality Benguella to Bihé, Angola, with which yours agree exceedingly well." These Angolan frogs were submitted for my examination and I concur with Mr. Parker's opinion as to their subspecific identity with the Dabaga series.

Coloration in life.— Most unfortunately the detailed color notes made in the field were inadvertently destroyed after my return. From memory I recall that the males had bright yellow throats.

Measurements.— Type ♀. Head and body 44 mm., breadth of head 15 mm., length of head 15.5 mm., length of snout 8.5 mm., length of hind limb 80 mm., length of 4th toe 22 mm. Paratype ♂. 42 mm.

Arthroleptis ukingensis sp. nov.

Type.— Museum of Comparative Zoölogy, No. 17,137. An adult ♀ from Madehani, Ukinga Mountains, Tanganyika Territory, collected by Arthur Loveridge, February 14, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 17,138–9 taken at the same place and time as the type, and Nos. 17,076–8 from Ilolo, Rungwe district, Tanganyika Territory, collected by Arthur Loveridge, March 15, 1930.

Diagnosis.— Near *A. minutus* Boulenger from which it is distinguished by very well developed digital expansions.

Tongue with a conical papilla. Snout moderate, much longer than the horizontal diameter of the eye; nostril much nearer to the end of the snout than the eye; interorbital space much broader than an upper eyelid; tympanum concealed. Tips of fingers and toes dilated into distinct disks (a condition more marked in life than as now preserved, since the specimens have suffered from frequent removal from alcohol, which has resulted in the shrinking of the disks on some of the toes); 1st finger shorter than the 2d, which is shorter than the 4th, the 3d being much the longest; a tarsal and two metatarsal tubercles; toes webbed, the four terminal joints of the 4th toe free, three terminal joints on the 3d and 5th toes free; only two terminal joints on the 1st and 2d toes free; the tibio-tarsal articulation of the adpressed hind limb reaches the eye. Skin of back smooth with inconspicuous flattened warts.

Coloration in life.— Type ♀. Above, like the ♂ but darker by reason of denser mottling; a light vertebral line from snout to anus, similar lines on thighs and tibiae. Below, largely transparent posteriorly but the throat presenting a varnished appearance and dusky specklings which extend to the breast well between the forearms, the breast to midbody with the satiny appearance as noted below for the male.

Paratype ♂. Above, olive, very minutely mottled with dusky brown. Below, largely transparent except for the throat which is dusky and a patch across the belly at midbody which is cream colored with a satiny gloss.

Measurements.— Type ♀. Head and body 18 mm., breadth of head 7 mm., length of head 7 mm., length of snout 3.5 mm., length of hind limb 27 mm., length of 4th toe 7 mm. Paratype ♂♂. 16 mm.

Arthroleptis rungwensis sp. nov.

Type.— Museum of Comparative Zoölogy, No. 17,141. An adult ♀ from just below the Moravian Mission at Ilolo at the base of Rungwe Mountain, southwestern Tanganyika Territory, collected by Arthur Loveridge, March 15, 1930.

Diagnosis.— Closely related to *A. minutus* Boulenger, from which it may be distinguished by its larger size, 24 mm. as against 22 mm., more extensive webbing of the toes and longer snout which is greater than the orbital diameter. It has been compared with the type of *minutus* by Mr. H. W. Parker who considers them distinct. Further discussion on its affinities will be published in due course.

Tongue with a conical papilla. Snout longer than the horizontal diameter of the eye; nostril nearer to the end of the snout than to the eye; interorbital space equal to, or a trifle wider than, an upper eyelid; tympanum hidden. Tips of fingers and toes tapering, not dilated; 1st finger much shorter than the 2d, which is shorter than the 4th, the 3d being much the longest; a rather indistinct tarsal tubercle; an inner and an outer metatarsal tubercle, the latter being larger and more compressed than in *A. minutus;* toes webbed, the three terminal joints of the 4th toe free, only two terminal joints free on the other four toes, thus the webbing is slightly more extensive than in *minutus;* the tibio-tarsal articulation of the adpressed hind limb reaches to the eye. Skin of back smooth with flattened warts.

Coloration in alcohol.— Type ♀. Above, dusky brown, heavily overlaid with black, the latter forming distinct cross bars on the

hind limbs. Below, white, blotched with brown on the throat as far back as the forearms and also along the flanks.

Measurements.— Type ♀. Head and body 24 mm., breadth of head 8.5 mm., length of head 8.5 mm., length of snout 3.5 mm., length of hind limb 33 mm., length of 4th toe 10 mm.

Probreviceps macrodactylus rungwensis subsp. nov.

Type.— Museum of Comparative Zoölogy, No. 16,451. An adult ♀ from the Nkuka Forest, Rungwe Mountain, southwestern Tanganyika Territory, collected by Arthur Loveridge, March 25, 1930.

Paratypes.— Museum of Comparative Zoölogy, Nos. 16,452–4, taken at the same locality as the type during March, 1930.

Diagnosis.— Agrees with *Probreviceps m. macrodactylus* (Nieden) of the Usambara Mountains excepting in the tympanum (which happens to be a good character in this genus). The diameter of the tympanum, which varies in distinctness, equals that of the eye in *P. m. rungwensis* and is two-thirds that of the eye in *P. m. macrodactylus*. Having noted this in the field with a view to describing the form as new, I placed this material at the disposal of Mr. H. W. Parker when engaged on his revision of this and allied genera; after comparing them with a topotypic series of *macrodactylus* he confirms this conclusion and the validity of the new form.

Coloration in life.— As in the typical form.

Measurements.—	Type ♀	Paratype ♀	Paratype ♂♂
Head and body	58 mm.	48 mm.	23–40 mm.
Length of head	17 mm.	15 mm.	11 mm.
Breadth of head	20 mm.	17 mm.	12 mm.
Diameter of orbit	4 mm.	4 mm.	3.5 mm.
Diameter of tympanum	4 mm.	4 mm.	4 mm.
Length of tibia	21 mm.	21 mm.	15 mm.
Length of foot	33 mm.	32 mm.	23–23 mm.

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THE OSTEOLOGY OF MESOHIPPUS BARBOURI

BY ERICH M. SCHLAIKJER

WITH FIVE PLATES

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No. 11.—*The Osteology of Mesohippus barbouri*

By Erich M. Schlaikjer

Introduction

The subject of this paper is the detailed description of a new and unusually complete *Mesohippus*[1] skeleton from the White River formation of South Dakota. This skeleton was collected during the summer of 1928 by a fossil-collecting party, under the direction of the writer, sent out by the Museum of Comparative Zoölogy at Harvard University.

To my knowledge there have been twenty species named of the genus *Mesohippus*. Many of these species, if not most of them, were based on very fragmentary material, and it is doubtful if all of them are valid. This, however, is not a subject to be discussed in these pages. The only detailed osteological description of *Mesohippus* is one by Professor W. B. Scott of Princeton. Until more complete skeletal material is found, it will be almost impossible to determine which of the less important osteological characters of *Mesohippus* are specific and which are individual variations. For this reason it does not seem advisable to make a detailed comparison of the characters found in the skeleton described here with the characters found in *M. bairdi*. I have chosen to make this paper primarily one of description, and wish to point out that the specimen herein described presents a number of striking characteristics different from those seen in *Mesohippus* as previously known.

A summary of the outstanding characteristics of this skeleton is as follows: (1) strikingly developed alveolar portion of the premaxillary; (2) anterior region of nasals narrow; (3) prominent facial crest on maxillary; (4) large, deeply cupped incisors; (5) premolar-molar series especially long in proportion to skull's length; (6) teeth crowns very tall; (7) incisor alveolus of mandible broadly expanded; (8) inferior incisors large and with tall crowns; (9) inferior canine very incisiform and set close against I_3; (10) inferior premolars and molars present only minute indication of external cinguli; (11) the posterior dorsals and the lumbars form no curvature of the vertebral column when articulated; (12) scapula small; (13) humerus very short in proportion to length of metacarpal III; (14) metacarpal V a mere

[1] Proc. N. E. Zoöl. Club, **12**, 1931, pp. 35-36.

nodule of bone; (15) lateral and medial digits reduced so they were non-functional in standing position; (16) femur very short in proportion to length of metatarsal III.

It is evident that this specimen deserved a new specific name, and I therefore proposed that it be called *Mesohippus barbouri* in recognition of Dr. Thomas Barbour's sincere interest in enlarging the vertebrate fossil collection at the Museum of Comparative Zoölogy.

There can be no mistake about the geological horizon in which the specimen was found. It was collected from the White River formation in the Big White River Bad Lands, Washington County, South Dakota, and was found in the upper concretionary formation which lies in the upper middle Oreodon zone.

I owe my gratitude to Dr. C. C. Mook and to the other members of the Department of Vertebrate Palaeontology in the American Museum of Natural History for the permission to study their splendid horse material; also to Dr. W. K. Gregory of that institution for his kind and ever helpful suggestions.

Detailed Osteological Description

In general, the portions of the skeleton which have not been preserved are the following: the anterior region of the nasals; right I^{1-3} and left I^1; the third, fourth and fifth cervicals; the twelfth dorsal; the posterior part of the sacrum and all the caudals; a large number of the neural spines; the pelvis; most of the left hind limb; most of the ribs; and the sternum. All the other bones of the skeleton are beautifully preserved, with practically no distortion.

Upper Dentition

The dentition of the specimen is unusually well preserved. Incisors two and three on the left side are present. The others are missing. They are exceptionally large. The crowns are especially long, are deeply cupped, and occupy a vertical position. The roots slope upward and backward. The crowns of both canines are missing, but the prominent roots indicate that they were quite large and were not erect. P^1 is large and has a strong internal cingulum. It was functional. The crowns of P^2 to M^3 are exceptionally tall. P^2 is smaller than any of the remaining teeth. The parastyle is little developed, though the tooth is not quadrate in outline. The protoloph is continuous with the ectoloph. The metaconule and the hypocone are

united. The internal cingulum is just slightly developed. The anterior cingulum is minute. The crown is not greatly worn. P^3 and P^4 are very molar-like, and are rather quadrate in outline. There is no indication of an internal cingulum on these two teeth. The anterior cingulum is more pronounced on P^4 than on P^3. The hypostyle is rather prominent and is somewhat triangular in shape. P^4 is distinctly larger than P^3 and slightly larger than M^1. M^{1-3} are rhomboidal in outline. M^1 is less so than the others. There is a prominent oval-shaped hypostyle on all three molars. There is no indication of an internal cingulum on M^1 and M^2, and there is only a slight indication of one on M^3. The protoloph and metaloph are rather oblique to the ectoloph on P^3 to M^3. The metaloph is not continuous with the ectoloph in any of the premolars or molars.

The Skull

The skull is beautifully preserved. There is almost no distortion. The only missing parts are: right I^{1-3} and left I^1; the anterior half of left P^3; the posterior half of right P^3; a small portion of left P^2; the anterior part of the nasals; the distal portion of the right paramastoid process; the left tympanic bulla; and a chip is missing from the anterior of the right facial crest. A portion of the maxillaries and premaxillaries is chipped away, and a very fine cast of the interior of the skull is exposed in this region.

The occipital condyles are proportionately narrow and are oblique in position. The dorsal parts of the articular faces terminate in rather deep kidney-shaped depressions, forming a sort of constriction just above the foramen magnum. The foramen magnum is almost circular in outline, and in the median dorsal position a slight groove extends upward for a short distance along the external surface of the occipital. Ventrally the condyles are separated by a narrow, shallow groove. Near the anterior border of the basi-occipital are two slightly prominent rugosities separated by the median line. The paramastoid process is slender, somewhat compressed and extends quite far below the level of the condyles. Its position is almost at right angles to the base line of the skull (a line extending from the optic foramen to the dorsal border of the foramen magnum). The distal portion is curved slightly inward. The supraoccipital is rather narrow and extends a moderate distance on the roof of the cranium. A slight median ridge, with a shallow depression on either side extends along the median line of the upper half of the supraoccipital. The lambdoid crest is rugose. The squamosal is large, and extends upward far enough to form the wall of

the widest portion of the brain. The zygomatic portion extends forward forming a small part of the inferior border of the orbit. The articular surface of the glenoid cavity is concave from side to side and convex antero-posteriorly; more so in the central portion than exteriorly, where it is broad and somewhat flattened. The post glenoid process is high and massive. It is somewhat flattened antero-posteriorly, and the intero-anterior portion is articular.

The mastoid process is not unusually large. The bulla is not coössified with the tympanic, but is held firmly to it by the hyoid process which is deeply imbedded in a groove in the bulla. The anterior border of the external acoustic meatus is quite heavy.

The basisphenoid is arched posteriorly and becomes flattened as it extends under the vomer. The pterygoid process extends downward and forward and is quite pronounced. The alisphenoid extends laterally and dorsally from the basisphenoid at a quite gentle slope along the base of the brain. The anterior portion then bends upward and forward rather sharply and continues to about half the height of the squamosal.

In front of the ascending portion of the alisphenoid is the ethmoid bone. It is narrow and lies in a vertical position. The posterior border extends the length of the ascending alisphenoid and then continues upward and forward meeting the anterior border, together with which it forms a pointed projection under the postorbital process.

The lachrymal bone forms the greater part of the anterior portion of the orbit. The oval-shaped lachrymal fossa is large and is situated near the border of the orbit. There is a deep antorbital depression centrally located on the facial part of the lachrymal.

The jugal bone forms the lower border of the orbit. Superiorly the maxillo-jugal suture is vertical, and inferiorly it extends downward and backward. The lower region of the jugal presents a prominent facial crest which is continuous in front with a similar crest on the maxillary.

The parietals form the greater portion of the cranial roof. In each the posterior width is one-fourth narrower than the anterior width. The sagittal crest is low and in front it separates into two ridge-like lines which curve outward and forward to meet the frontal crests.

Lying bluntly wedged between the foremost parts of the parietals are the frontal bones which are prominently convex in this region. The area just behind the postorbital processes is comparatively wide, indicating a degree of intelligence which perhaps surpassed that of the near Oligocene relatives of this animal. The postorbital process is

moderately long, extending downward two-thirds the distance to the zygomatic arch. Just in front of the process is a deep notch which is preceded by a prominent tubercle. The anterior portion of the frontals is flattened; and at the median line they extend only slightly between the nasals.

The nasal bones are triangular in outline. Posteriorly they are flattened. The anterior portion is tranversely convex and exceptionally narrow.

The alveolar portion of the premaxillaries is strikingly developed for *Mesohippus*. The transverse measurement between the alveoli of incisors three is 22 mm. The vertical diameter is also comparatively large. At the median line there is evidence of a foramen incisivum. The diastema between incisor three and the canine measures one-fourth the distance of the canine-premolar diastema. The ascending portion of the premaxillary is quite oblique in position. The uppermost portion is missing and in restoring I have tried to follow out the curvature of the parts that have been preserved. The position of the premaxillaries and the nasals seems to indicate that the anterior nares were quite high, and were broader below than above. It is difficult to determine the exact extent of the palatine plates of the premaxillaries as they are not entirely preserved.

The facial portion of the maxillary is somewhat convex below, and rather concave above; particularly in the anterior region. The maxillary portion of the facial crest stands out considerably from the tooth row and lies above the posterior half of the first molar. It has the form of a prominent elongated tubercle. The infraorbital foramen is situated twenty-six millimeters in front of the orbit and eighteen millimeters above the front of premolar four. The diastema between the canine and the first premolar is unusually short. There is a rather abrupt constriction of the maxillaries at about the middle of the diastema, although this region is comparatively broad. The palatine surface is transversely convex and is slightly raised along the median suture. The alveolar tuberosity extends a good distance behind the last molar and is square in outline.

The palatines form the anterior margin and the lateral walls of the posterior nares. They do not greatly constrict the opening posteriorly. The inferior portion of the wall of the orbit is formed by the palatine bone and it extends forward to make contact with the lachrymal.

The vomer is long and narrow and is slightly constricted where it articulates with the pterygoids.

The Skull in General

The broad diameter across the molar region, the uniformity in width throughout the length of the zygomatic arches, and the comparatively expanded cerebral region give the skull a broad massive appearance. The area anterior to the frontals is constricted though it is relatively long. The great development of the premaxillary alveolar region is certainly an advanced characteristic and is unusual in the genus *Mesohippus*. It is therefore one of the striking features of the skull. The large cupped incisors, the tall crowns of the premolars and molars, and the comparatively long tooth series are additional characteristics of the skull showing advancement at this stage of the evolution of the horse.

Lower Dentition

Right P_1 and P_2, and the anterior portion of left P_3 are missing; otherwise the lower dentition is complete. The incisors are very large and the crowns are exceptionally long. I_3 is slightly smaller then I_1 and I_2. Each has an internal "cingule" (a term that I suggest to describe a flattened cone-like cusp occupying the position of a cingulum) which is situated outwardly from the median line. A quite prominent ridge extends from the outer rim down to the inner base of the cingule. There is a pocket-like depression on either side of the ridge. The outer depression is slightly deeper than the inner one. These depressions are deepest in I_3.

The canine is set closely against I_3 and is very incisiform. A rather heavy ridge extends from the outer rim to the internal base, and has a slight depression on each side. The posterior depression is a little more pronounced than the anterior one.

P_1 is minute and is set close to P_2. The tooth is compressed laterally. There is a shallow depression in the anterior internal portion of the crown, and the posterior portion presents a V-shaped ravine at the base of which is a well defined entoconid. The tooth, therefore, has practically the same form as P_2 though it is very much smaller. It was not functional at the time of the animal's death. P_2 is incompletely molariform, the metaconid not being developed. P_4 is the largest tooth of the $P_1 — M_2$ series. M_3 has a well developed, deeply cupped hypoconulid, and is therefore the longest of any of the inferior teeth. P_4 has the greatest breadth. There is only the very slightest indication of an external cingulum on any of the inferior molars.

The Mandible

The horizontal ramus is elongated. It tapers forward and is biconvex in transverse vertical section. The two rami are firmly fused at the symphysis, which is somewhat shortened. There is a rather sharp constriction at the diastema, but this region is comparatively broad. The incisor alveolus is broadly expanded. The symphysial region is extended upward and forward at a rather sharp angle from the remaining portion of the horizontal ramus. This shortening and angulation of the symphysial region was probably necessary to supply additional strength for the support of the large incisors. The ventral border of the ramus posterior to the symphysis is nearly straight. At its posterior part the vascular impression is fairly well marked. The angle is rounded. Its posterior border is thickened and slightly medially curved. The foramen mandibulare is large and is situated on a level with the base of the tooth row. The condyle is considerably elevated above the level of the molars. It is extended transversely and occupies an oblique position, the inner portion being directed backward and downward. The coronoid process extends high above the condyle. It is thin transversely, curved backward and slightly inward.

Skull Measurements

	mm.
Basal length	167.5
Condylo-basal length	176.
Zygomatic breadth	85.
Greatest breadth across squamosals on molar arches	82.
Greatest breadth across squamosals on cranium	52.
Breadth on upper rim of post glenoid notch	51.5
Interorbital breadth across frontals	45.
Distance from anterior rim of orbit to pmx. (I alveoli)	88.
Distance from anterior rim of orbit to supraorbital crest	110.
Distance from mandibular condyle to pmx.	146.
Breadth of muzzle at anterior root of M^1	60.5
Distance from anterior end of internal nares to pmx. (I alveoli)	80.
Distance from anterior end of internal nares to condyles	96.
Greatest width of condyles	30.5
Distance from ventral portion of exocc. to top of Supraocc.	48.
Width of premaxillaries at posterior of I^3 alveoli	24.5
Breadth across P^2 to P^2 at center of crown	56.
Breadth across P^4 to P^4 at center of crown	57.

	mm.
Breadth across M^1 to M^1 at center of crown	59.
Breadth across M^3 to M^3 at center of crown	58.
Length of diastema (I^3 to P^1) external	22.
Molar series on alveoli (P^1 to M^3) external	76.
Distance from P^2 to P^4 on alveoli (external)	35.
Distance from M^1 to M^3 on alveoli (external)	35.
Height of crown of I^2 at center of tooth (external)	5.5
Lateral distance across I^2	7.
Fore and aft distance at center of I^2	5.5
Height of crown of I^3	5.5
Lateral distance across I^3	7.
Fore and aft distance at center of I^3	5.5
Height of crown of P^1 at highest point (external)	5.5
Height of crown of P^2 on paracone (external)	8.
Breadth of P^2 at center of crown	11.5
Length of P^2 at center of crown	10.
Height of crown of P^3 on paracone (external)	9.5
Height of crown of P^4, $M^{1, 2, 3}$ on paracone (external)	10.5
Breadth of P^4 at center of crown	14.5
Length of P^4 at center of crown	12.5
Breadth of M^1 at center of crown	14.5
Length of M^1 at center of crown	12.5
Breadth of M^3 at center of crown	14.
Length of M^3 at center of crown	11.
Greatest breadth of M^3	15.5
Greatest length of M^3	13.

The Vertebral Column

Atlas: This vertebra is broad in proportion to its length. The anterior articular cavities are deep. They almost meet ventrally, but dorsally they are widely separated by a broad notch. The neural arch is broad and high. Medially there is a prominent, sharply convex region. There is only a slight indication of a ridge above the intervertebral foramen. The ventral arch is more massive, narrower, and shorter than the dorsal arch. The surface is flattened. The hypapophysial tubercle is posterior in position. It is fairly large and very prominent. The posterior articular faces are high. They are widely separated above and are nearly confluent below. The surfaces are slightly convex and the inner borders are rounded off. The wing is

somewhat short, but fore and aft it is quite extended. The dorsal surface is slightly concave. At the anterior base is the spinal nerve notch which is fairly deep. The foramen transversarium is situated on the border of the posterior root of the wing where it meets the articular face. The fossa atlantis is large, rounded and deep. The posterior border is narrow.

Axis: Only the anterior region of the axis is preserved. The odontoid process is broad and is turned upward at the end. It has a low convex ventral surface; the dorsal surface presents a fairly prominent median ridge with a depression on either side. The anterior articular processes are low, broad, and are confluent with the lateral margins of the odontoid process. The articular surfaces are slightly concave transversely and markedly convex dorso-ventrally.

Cervicals: The third, fourth, and fifth cervicals are absent. The sixth cervical vertebra is deep and massive. The neural spine is incomplete, but the portion present indicates that it was scarcely more than a prominent ridge. The prezygapophyses are missing. The postzygapophyses project slightly behind the neural spine. The transverse process is straight, short, and heavy. The front part of the inferior lamella is not preserved. Posteriorly the lamella extends far downward and slightly outward; its inferior border is flattened. Below the posterior end of the foramen transversarium is a rather large fossa. The head of the centrum is oval-shaped; it is wider and more flattened above than below.

The seventh cervical is considerably shorter, but is wider than the sixth. The neural spine is very short, measuring only eighteen millimeters above the dorsal border of the neural canal. The prezygapophyses are wider than the postzygapophyses; the latter extend slightly behind the neural spine. The transverse process is moderately long. The distal border is bent upward and is thickened; anteriorly it is bent downward and is thin. The posterior part of the centrum is wide and flat.

Dorsals: The exact number of dorsal vertebrae is uncertain. The matrix containing the specimen was broken just behind the eleventh dorsal. I have reckoned the twelfth to be missing. The remaining five were in continuous series; thus making seventeen dorsals in the mounted specimen. The first of the series resembles the seventh cervical in some respects. The centrum is flattened, though it is shorter and the median ventral portion is heavier. The transverse process is even longer and is formed into a deep semi-circular facet for the tubercle of the first rib. The prezygapophyses are wider than

the postzygapophyses, and the latter extend only slightly behind the neural spine. The neural spine is thin in front and broad behind; giving it a triangular shape when viewed from above. There is a median ridge on its posterior border. The succeeding dorsals show modifications of these characters. The neural spine is heaviest on the second dorsal; from there on back to the thirteenth it gradually becomes lighter. Only a small part is missing from the end of the spine of the second dorsal. The tips are missing from the next four, and the greater portion of each spine of the others has been lost. In restoring the missing ones I have been guided only by what remains of each. The semi-circular facets on the transverse processes are gradually reduced so that they are flattened on the sixth to the last. The zygapophyses on the third to the sixteenth are developed on the neural arch. The last dorsal is the only one which has a median ventral keel; the keel shows greater development in front than behind. The vertebra also presents a quite prominent elongated tubercle on the side of the centrum behind the rib facet. From the fifteenth to the seventeenth the length of the centrum gradually increases.

Lumbars: The lumbar vertebrae were discontinuous behind the third of the series. Two lumbar centra were associated with the specimen, and I have considered them to be the fourth and fifth. The sixth and seventh were continuous with the sacrum. All of the lumbars are fairly completely preserved. A large amount of each neural spine is preserved, except on four and five where only the centra remain. The seventh is the only one which retains the greater portion of its transverse processes. The centra of the first four are quite elliptical in cross-section and have a distinct ventral crest. From the fifth to the last the centra become more flattened and the ventral crest disappears. The basal portions preserved of the transverse processes indicate that they were moderately massive and that they extended outward and slightly downward. On the last three they project moderately forward. The transverse process of the last lumbar has a thickened oval-shaped facet for articulation with the wing of the sacrum.

Sacrum: Only the first of the sacral vertebrae is preserved. The centrum is considerably flattened. The wing is massive and curves slightly downward. On its anterior border is a convex surface which fits into the facet on the transverse process of the last lumbar. On the postero-dorsal surface of the wing is the elongated, concave, rugose, articular surface for articulation with the ilium.

Caudals: None of the caudal vertebrae are preserved.

Vertebral Column in General

The vertebral column presents a number of interesting features, such as: the shape of the neural arch of the atlas and the position of the foramen transversarium on that vertebra; the shortness of the neural spines on the sixth and seventh cervicals; the absence of a ventral keel on all the dorsals except the last; and many other similar characters. But perhaps most striking of all is the lack of curvature of the column when the vertebrae are articulated. The posterior cervicals and the anterior dorsals form a downward curving of the column but the posterior dorsals together with the lumbars almost form a horizontal line. This certainly seems to be an advanced characteristic.

The Ribs

Most of the ribs are lacking. The first three and the fifth on the left side and the second and third on the right were found in position and are complete. They are comparatively short; the first is rounded and slender, but the others are broad and very flattened. The proximal ends and various parts of a number of others are present. None of the sternum was preserved but the increase in length of the first five ribs seems to indicate that it must have occupied a position oblique to the long axis of the horse's body.

Bones of the Fore Limb

The greater portion of the left scapula and a good deal of the right is preserved; all the remaining bones of the fore limbs, including a number of the sesamoids, are complete and were articulated.

Scapula: The glenoid cavity is slightly longer than broad, and it is fairly shallow. The coracoid process is large and massive; it is somewhat recurved at the distal end. The neck is long and exceptionally slender. The anterior border is moderately thick near the coracoid process. The posterior border on the lower half of the scapula is considerably thickened. The distal part of the scapula is erect, but the proximal region is curved in, giving it the appearance of a bow when viewed from behind or in front. The spine is tall and is bent sharply backwards.

Humerus: This bone is proportionately very short for *Mesohippus*. The head is large, strongly convex and is rather circular in outline. The external margin is considerably lower than the internal. This, along with the strong convexity of the surface, perhaps indicates that

there was a good deal of lateral swing to the forelimb during locomotion. The anterior portion is large and overhangs the bicipital groove. The more lateral part is well developed and its outer surface presents a large rugose triangular area for the attachment of the infraspinatus muscle. At the bottom of the bicipital groove there is a slight indication of a tubercle. The inner tuberosity is large and has a flattened dorsal surface. The shaft is comparatively slender and is twisted; it is irregularly oval-shaped. The deltoid tuberosity is prominent and rugose. The distal end is somewhat broadly expanded; the trochlea is oblique to the long axis of the shaft and the epicondyles are fairly well developed.

Radius: The radius is comparatively long. The shaft is gently curved forward and is flattened antero-posteriorly; more so medially than laterally. It is rather expanded at both ends. The interior facet of the proximal end is fairly shallow and is larger than the narrow median facet. The external facet is large and flattened; it extends outward and upward. The distal end is massive. The grooves for the common and lateral extensor tendons are well marked. On the inner anterior surface there is a shallow oblique groove for the tendon of the extensor carpi obliquus muscle. The scaphoid facet is quadrilateral and is concavo-convex from before backwards. The lunar facet is similar in shape, though with less convexity and with more transverse expansion.

Ulna: The ulna is much reduced. The olecranon is high and massive. The medial side is concave, the lateral is convex. The top presents a heavy rounded tubercle situated posteriorly. There is a prominent ridge extending from the tubercle with a fairly large, flattened face on either side. The processus anconaeus is very prominent. The semilunar notch is rather deep and its surface is convex transversely. The distal end of the ulna is not fused with the radius. Its articular face is convex and bears a postero-internal groove.

Carpus: The scaphoid is deep, somewhat laterally compressed and is rather six-sided in appearance. The anterior portion of the dorsal surface is convex and the posterior is concave. There is an upper and a lower facet for the articulation with the lunar. On the distal surface the magnum articulation is slightly convex. Directly behind is the facet for the trapezoid which is rounded and concave. There is a minute facet behind this for the trapezium.

The lunar is proportionally long; it is wider in front than behind. The dorsal surface is saddle-shaped. Laterally the lunar is in contact with the scaphoid at the superior and inferior margins. It is in continuous contact with the cuneiform. The ventral surface is narrower

than the dorsal. The articulation with the magnum is only slightly wider than the unciform articulation. There is a tubercle on the ventro-posterior surface.

The cuneiform is narrow above and broad below. On the anterior internal proximal surface there is a small triangular facet for the radius. The ulna facet is concave and is higher in front than behind. On the distal surface the unciform is concave and is triangular in outline. The pisiform facet is oblique in position.

The pisiform is deep, somewhat flattened and moderately long. The internal surface is concave and smooth. The external surface is convex and rugose. Its anterior part bears a shallow oblique groove for the long tendon of the ulnaris lateralis. The facet for the ulna is round and convex. The cuneiform facet is antero-inferiorly situated. It is elongated and convex, and is separated from the ulna facet.

The trapezium is not preserved.

The trapezoid is low and rather wedge-shaped, being narrow in front and broad behind. The proximal surface is convex and continuous on the volar surface. The distal surface is flattened. The articulation for metacarpal II is rather triangular in outline. There is a narrow elongated articular surface on the ventral border for articulation with the magnum.

The magnum is the broadest of any of the distal carpal bones. On the proximal surface, the facet for the scaphoid is twice as broad as the facet for the lunar. The distal surface is broadly triangular in outline and is almost flat.

The unciform is somewhat shortened, its greatest length being only one-fourth greater than that of the magnum. It is rather broad. On the proximal surface the lunar facet is fairly large and has a dorsal lateral position. The cuneiform is slightly convex. On the distal surface, the facet for metacarpal IV is slightly concavo-convex from before backwards. The facet for metacarpal III is ventro-laterally situated. There is a small facet for metacarpal V.

Metacarpus: Metacarpal III is long in proportion to the other bones of the limb. The shaft is rather semi-elliptical. The anterior surface is transversely convex. The posterior surface is slightly convex from side to side and there is a medial shallow groove running longitudinally. The proximal surface is flattened anteriorly, and it bends down to a certain extent posteriorly. The unciform facet is oblique in position. The distal end is expanded and thickened. The carina is prominent and extends slightly anterior to the center of the long axis of the bone. On either side of the articular surface is a small fossa above which is a prominent tubercle.

The lateral metacarpals are shorter, thinner, and more compressed than metacarpal III. Metacarpal IV is the shorter of the two. The distal extremities are rounded and the carinae are mostly confined to the posterior.

Metacarpal V is minutely represented — its greatest length being only eleven millimeters. The head is half the size of that of metacarpal IV. The entire metacarpal amounts to nothing more than a nodule of bone.

Phalanges: The phalanges of the lateral digits are short and stubby; the unguals are short, narrow, and pointed. Those of the middle digit are very much larger. The first phalanx is long, broad and thickened above, and more narrow and compressed below. The second phalanx is much broader than it is long. It is not quite two-thirds as long as the first and is much compressed antero-posteriorly. The ungual phalanx is somewhat longer than it is broad. The dorsal surface is strongly convex. The ventral surface is prominent but not greatly extended posteriorly. The distal border is notched and a V-shaped groove extends upward from the notch a short distance along the dorsal surface.

Measurements

	mm.
Length of scapula	134.
Fore and aft diameter of glenoid cavity	19.5
Transverse diameter of glenoid cavity	17.
Distance from coronoid process to posterior rim of glenoid cavity	27.
Narrowest fore and aft distance of neck of scapula	13.5
Length of humerus, external tubercle to posterior trochlea	123.
Length of humerus, head to posterior trochlea	117.
Shortest width of shaft	11.
Shortest fore and aft distance of shaft	14.
Width of distal end of humerus on lateral ligament depressions	23.5
Greatest length of ulna	166.
Length of radius on inner side	130.
Greatest width of proximal end of radius	24.5
Greatest width of distal end of radius	21.
Width at center of radius shaft	14.
Greatest height of lunar	13.
Greatest height of magnum	8.
Width of magnum (anterior)	10.5

	mm.
Greatest length of metacarpal III	102.
Greatest width at proximal end of metacarpal III	12.
Greatest width at distal end of metacarpal III	14.5
Greatest length of metacarpal II	95.5
Greatest length of metacarpal IV	91.
Greatest length of metacarpal V	11.
Lateral median length of first phalanx, 3d digit	14.
Lateral median length of second phalanx, 3d digit	9.
Median dorsal length of ungual phalanx, 3d digit	17.5
Width of ungual phalanx (across angles) 3d digit	15.

Bones of the Hind Limb

Practically all of the right hind limb is preserved. The pelvis and the left hind limb, with the exception of a part of the proximal end of the femur and most of the astragalus, are missing.

Femur: In proportion to the length of the metatarsals the femur is very short. The proximal end is large. The head is practically hemispherical and is directed upward, forward and inward. The notch for the accessory and round ligaments is deep and broad. The great trochanter is very massive. The anterior part is low and rugose; a shallow notch separates it from the posterior part which stands high above the head and is medially curved at the end. The trochanteric fossa is elongated and deep. The second trochanter is prominent; the distal end of the third is missing but the region preserved indicates that it was well developed and was curved forward.

The shaft is stout. Just below the third trochanter it is laterally compressed and deep; it then becomes circular, and expands and deepens at the distal extremity.

The distal end is expanded both transversely and antero-posteriorly. The trochlea is broad and slightly oblique to the long axis of the shaft; the medial ridge is heavier and more extensive than the lateral. The condyles are large and extend rather far posteriorly; the lateral is much larger than the medial. The medial and lateral epicondyles are fairly prominent; the supracondyloid fossa is elongated and deep.

Tibia: This bone is long and rather slender. The proximal end is large and triangular in general outline when viewed from above. The condyles are saddle-shaped, and the lateral is broader than the medial. The intercondyloid eminence is prominent; the popliteal notch is broad and fairly deep. The sulcus muscularis is semicircular and

deep. The crest is very prominent and rugose, and occupies the upper third of the shaft. The distal end is narrow but massive; the medial portion is larger than the lateral. The articular facets for the astragalus are oblique to the long axis; the medial is narrower and deeper than the lateral.

Fibula: Both ends and a part of the distal region of the shaft are preserved. The proximal end is large; it is flattened transversely, and the anterior and posterior borders are rounded. The distal end and a part of the lower end of the shaft are coössified with the tibia. The end is expanded and the calcanear facet is large and flattened.

Patella: The patella is cubical in outline with a pointed postero-distal end. The anterior surface is strongly convex and rugose; the posterior presents two articular surfaces, of which the medial is slightly larger. The medial border is short and slightly convex; the lateral border is long and straight. The base is transversely convex and is slightly concave in the antero-posterior diameter.

Tarsus: The calcaneum is proportionately short; it is transversely compressed. The distal end of the body is thickened, rounded and rugose. The plantar border is straight and slightly expanded at each end. The posterior half of the dorsal border is straight. The cochlearis process is prominent and is expanded laterally. The sustentaculum is large and massive. The cuboid facet is somewhat narrowed and is slightly concave.

The trochlea of the astragalus is oblique in position; the groove is narrow and deep. The distal surface is transversely concave and is convex antero-posteriorly. There is a small cuboid facet. The distal part of the medial surface bears a large tuberosity.

The cuboid is deep, transversely compressed and is not in contact with metatarsal III. The navicular is low and broad. The meso- and ento-cuneiforms are coalesced. The ento-cuneiform is rounded posteriorly and is in contact with the cuboid; it is deeper than the meso-cuneiform. The ento-cuneiform is broad and rather low.

Metatarsus: Metatarsal III is proportionately long and fairly stout. The proximal end is narrow and deep and does not come into contact with the cuboid. The distal end is broadly expanded but massive. On the dorsal side above the articular surface is a transversely elongated shallow pit. The lateral tubercles are very prominent. Metatarsals II and IV are much shorter than metatarsal III and are much lighter in construction.

Phalanges: The phalanges of the hind foot are practically the same as those of the fore foot except they are more massive; the portions

preserved of the lateral and medial digits seem to indicate that they were slightly shorter.

Measurements

	mm.
Greatest length of femur	174.
Length of femur from head to internal trochlear ridge	157.
Length of femur, center of 3d trochanter, to external trochlear ridge	122.
Shortest transverse measurement of femur shaft	13.
Distance across condyles of femur	33.
Length of tibia from medial condyle to internal malleolus	182.
Length of fibula	169.
Metatarsal III (maximum length)	117.
Maximum width, proximally, of metatarsal III	13.
Maximum width, distally, of metatarsal III	15.
Maximum length of metatarsal II	113.
Maximum length of metatarsal IV	109.
Length of 1st phalanx, 3d digit	15.
Length of 2d phalanx, 3d digit, at center of side	10.
Length of ungual phalanx, 3d digit, dorsal	19.

The Limbs in General

Perhaps the most striking feature of the limbs is the shortness of the proximal elements as compared with the proportionately long metacarpals and metatarsals. It is a well known fact that lengthening of both proximal and distal limb elements creates a long stride in locomotion but retards speed. On the other hand, if only the distal elements of the limb are lengthened and if the proximal elements are shortened then both the stride and the motion of the limb are increased, thus giving the animal greater speed. According to the accompanying table, showing the metacarpo-humerus and metatarso-femur ratios, it seems evident that this specimen was proportionately more swift in running than were his near Oligocene relatives. It is indeed interesting to note that the speed of this little horse was, proportionately, perhaps even greater than that of the upper Oligocene "stilt-footed" *Mesohippus grallipes*.

Table showing a comparison of limb ratios of *M. barbouri* with those of other species of *Mesohippus*.

	Humerus head-tr.	Metac. III length	Ratio	Femur max. length	Metat. III	Ratio
M. barbouri M. C. Z. 17641	117.	102.	.872	174.	117.	.672
M. bairdi M. C. Z. 10682	128.	93.	.727	197.5	115.	.582
M. bairdi A. M. N. H. 1477	137.	88.	.642	220.5	115.	.522
M. grallipes Princeton museum 10729	176.	148.	.841	256.±	180.	.703

Another striking feature of the limbs is the reduction of the lateral and medial digits so they were non-functional in standing position. This does not mean, however, that they were entirely useless. They were probably still used to help keep the feet of the animal from miring deeply into the marshy lands on which it probably spent a good deal of its roving existence.

It is hoped that what has been written in the foregoing pages will contribute something to that which is already known of *Mesohippus*. To say what was the exact ancestry of *M. barbouri* would only be hypothetical. I believe, however, that this species represents a progressive line of three-toed horses which had its origin from some as yet undiscovered genus of horse in middle or late Eocene times; and from a species more advanced than that which gave rise to the line of Oligocene horses represented by *M. bairdi*.

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EXPLANATION OF PLATES

PLATE 1

PLATE 1

Mesohippus barbouri Schlaikjer

Skull, dorsal view. Actual size.

MCZ. 17641

PLATE 2

PLATE 2

Mesohippus barbouri Schlaikjer

Skull and jaws, left side. Actual size.

PLATE 3

PLATE 3

Mesohippus barbouri Schlaikjer

Skull and jaws, palatal view. Two-thirds actual size.

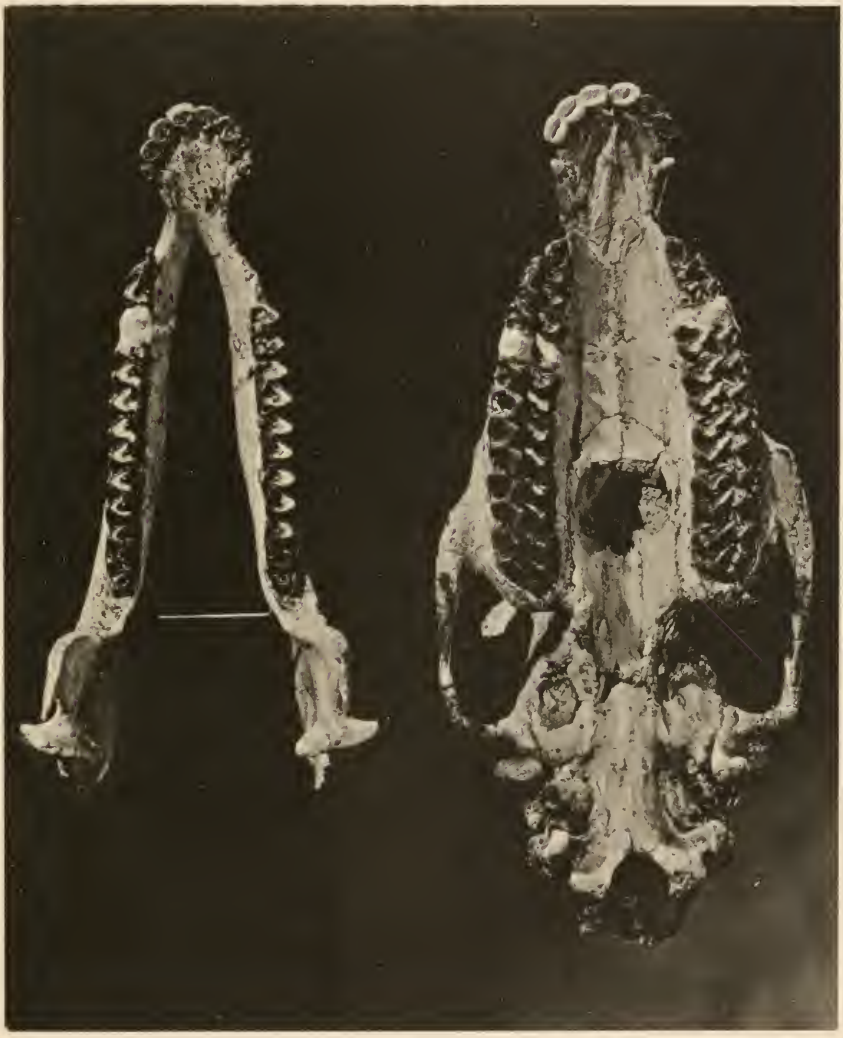

PLATE 4

PLATE 4

Mesohippus barbouri Schlaikjer

Vertebral column. Fig. 1, left side; fig. 2, ventral view; fig. 3, dorsal view. Reduced $4\frac{3}{4}$ times.

1 2 3

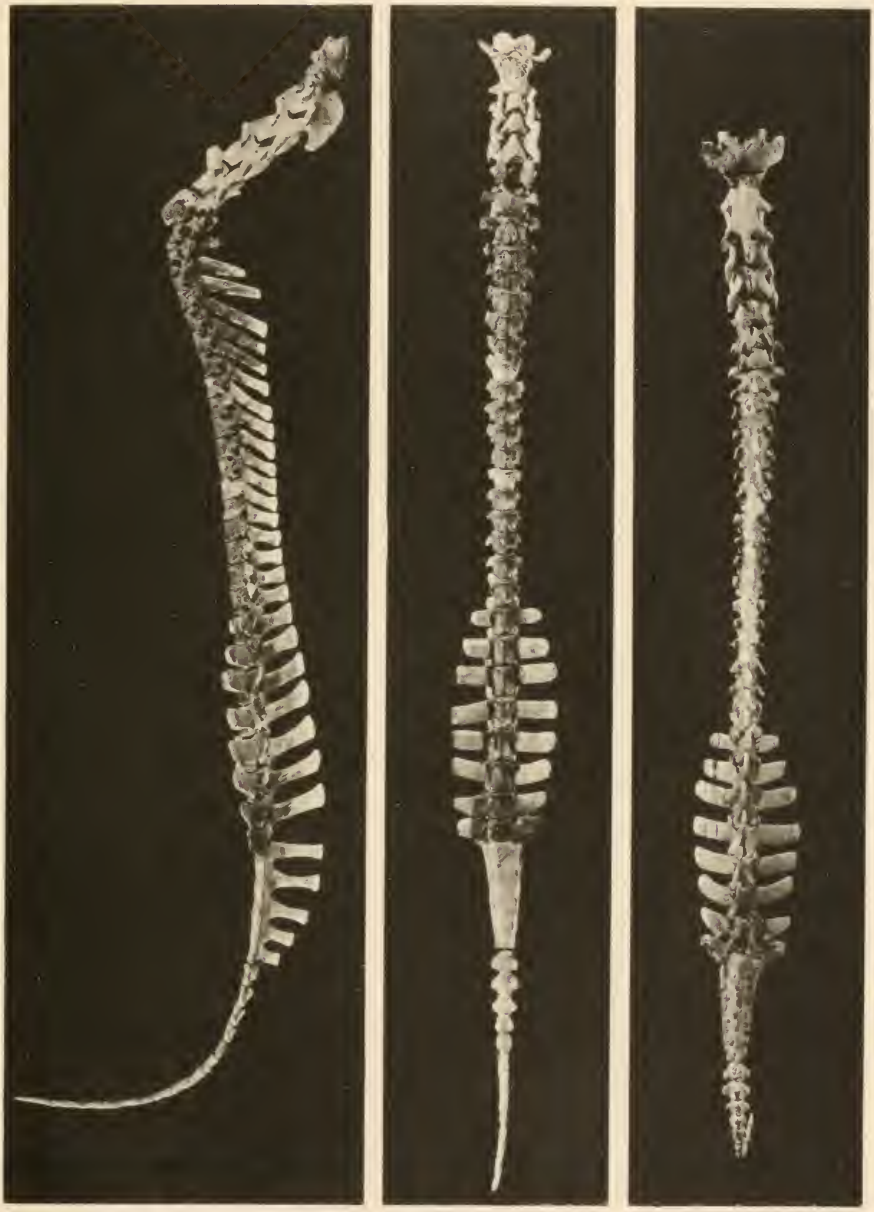

PLATE 5

PLATE 5

Mesohippus barbouri Schlaikjer

Mounted skeleton, right side. $\frac{1}{6}$ natural size.

Photographs by Irving Dutcher.
Skeleton mounted by Charles J. Lang.
All figures based on the type, M. C. Z. no. 17,641.

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